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**MONTANA DEPARTMENT OF STATE LANDS**  
**ABANDONED MINES AND RECLAMATION BUREAU**  
**ABANDONED HARDROCK MINE PRIORITY SITES**

**PROJECT REPORT**

**Summary, AIMSS,  
Data Validation/Evaluation, SAP, QAPjP,  
LAP, H&S Plan, Video Log**









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**SUMMARY REPORT  
FOR THE  
ABANDONED MINES  
HAZARDOUS MATERIALS INVENTORY**

**Abandoned Mine Reclamation Bureau  
Montana Department of State Lands  
1625 11th Avenue  
Helena, Montana 59620**

**MARCH 1994**







**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINES AND RECLAMATION BUREAU**

**ABANDONED HARDROCK MINE PRIORITY SITES**

**SUMMARY REPORT**

**PREPARED FOR:**

**ABANDONED MINES AND RECLAMATION BUREAU  
MONTANA DEPARTMENT OF STATE LANDS  
1625 ELEVENTH AVENUE  
HELENA, MONTANA 59620**

**PREPARED BY:**

**PIONEER TECHNICAL SERVICES, INC.  
P.O. BOX 3445  
BUTTE, MONTANA 59702**

**WITH ASSISTANCE BY:**

**THOMAS, DEAN AND HOSKINS, INC.  
1200 TWENTY-FIFTH STREET, SOUTH  
GREAT FALLS, MONTANA 59405**

**Engineering Services Agreement DSL-AMRB No.004**

**MARCH 1994**

The cover photograph is of the Maginnis Mine and Mill, Maiden, Montana located approximately 23 miles northeast of Lewistown, Montana. This photograph was taken by W.H. Culver and graciously provided by the Montana Historical Society for use on this cover.







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## 1.0 INTRODUCTION

This document provides a summary of the Hazardous Material Inventory Project implemented for the Abandoned Hardrock Mine Priority Sites. The Hazardous Materials Inventory was conducted for the Montana Department of State Lands, Abandoned Mine Reclamation Bureau (DSL-AMRB).

This report is organized into five sections. Section 1.0 presents the introduction, project objectives, a brief description of the project tasks, and a summary of the findings. Section 2.0 briefly describes field methods used during the inventory. Section 3.0 discusses data evaluation techniques and data management for the project. Section 4.0 presents a brief description of the Abandoned and Inactive Mines Scoring System (AIMSS) which was developed to rank the 270 priority sites. Section 5.0 presents one page summaries for each of the priority sites. The summaries typically provide details about each site, such as volumes of wastes, contaminant concentrations, observed releases to surface water and groundwater, water quality criteria exceedances, and potential safety hazards.

This summary report is supported by several other project documents databases, including:

- The Sampling and Analysis Plan (SAP) presents the sampling approach for the Abandoned Mines Hazardous Materials Inventory. This SAP also contains instructions on completing the Inventory Form and the Standard Operating Procedures (SOPs) for conducting the field sampling activities (Pioneer, 1993a).
- The Quality Assurance Project Plan (QAPP) describes quality assurance procedures used for evaluating the field and lab data for the project (Pioneer, 1993b).
- The Laboratory Analytical Protocol (LAP) describes laboratory requirements for the project (Pioneer, 1993c).
- The Health and Safety Plan describes practices and procedures to be followed by field investigators who performed the project to minimize exposure to hazardous materials and to eliminate any possibility of physical injury (Pioneer, 1993d).

- The Abandoned Hardrock Mines Project Report is a compilation of the reports listed above, as well as this Summary Report, the AIMSS Report, the Data Validation/Evaluation Report, and the completed Hazardous Material Inventory Forms for each site (Pioneer, 1994).
- The Abandoned Hardrock Mine Priority Sites, Hazardous Materials Inventory Databases.

The Abandoned Hardrock Mines Project Report can be viewed in Helena, Montana, at the Montana State Library; the DSL-AMRB office; or the Montana Department of Health and Environmental Sciences, Solid and Hazardous Waste Bureau (DHES-SHWB) office or in Missoula, Montana, at the United States Department of Agriculture, Forest Service (USFS), Region 1 office. A partial copy is also located at the United States Department of Interior, Bureau of Land Management (BLM) State Office in Billings, Montana.

## 1.1 PROJECT OBJECTIVES

There are an estimated 6,000 abandoned or inactive hardrock mine and milling sites in Montana. This legacy of Montana's mining past has left a wide range of problems and challenges for the DSL-AMRB and other state and federal agencies charged with the reclamation and mitigation of these problems.

The problems associated with the abandoned and inactive hardrock mine sites are varied and range from safety hazards caused by hazardous mine openings, dangerous high-walls, and dilapidated structures, to threats to human and non-human life and the environment by mining waste containing elevated heavy metals and other contaminants. To date, the DSL-AMRB has conducted a great deal of work to eliminate the problems of unsafe openings, high-walls, and structures, and has made over 1,500 of these sites safer.

In 1991, the DSL-AMRB concluded that substantial progress had been made in eliminating imminent hazards to public health and safety at abandoned hardrock mine sites. However, limited progress was realized with regard to the problems relating to heavy metal and mineral processing reagent contamination of surface water and



groundwater . Not only were these sites causing severe environmental degradation, but they were also the sites of highest concern to the public. Additionally, the DSL-AMRB recognized that there were a number of other state and federal programs that had resources available to address their problems, but there was no coordinated approach to determining which specific sites should be addressed first. As a result, the DSL-AMRB solicited various state and federal agencies, requesting assistance in the identification of suspected problem sites. The following agencies responded to the DSL-AMRB request: USFS-Region 1, BLM, DHES, and the Montana Department of Natural Resources and Conservation (DNRC). A list of 270 suspect sites was compiled from the input of these agencies supplemented by a review of existing data from the DSL-AMRB master inventory. This priority sites list is presented in Table 1-1. Although this list includes the majority of the highest potential hazard sites in Montana, several others have been identified and will continue to be identified, investigated, and ranked in the upcoming years by the DSL-AMRB.

The agencies previously listed agreed to a cooperative course of action, with DSL-AMRB designated as the lead agency. The agencies established the following objectives:

- To identify and prioritize those abandoned mine sites that are presently the most serious threats to public health and safety and the environment.
- To collect data on each priority site in a consistent manner to identify problems associated with each site and to directly compare and rank sites. All sampling and analysis methods will strictly follow U.S. Environmental Protection Agency (EPA) protocols to ensure consistent and accurate results.
- To develop a long-term strategy to utilize statutory and financial resources available to systematically reduce the hazards associated with the prioritized abandoned mine sites.

Upon completion of this report, the first two objectives stated above are fulfilled, and the framework to complete the third objective is in place.

| COUNTY     | DISTRICT       | SITE NAME              | PA No. | COUNTY        | DISTRICT      | SITE NAME               | PA No. | COUNTY        | DISTRICT         | SITE NAME              | PA No. | COUNTY      | DISTRICT      | SITE NAME               | PA No. |
|------------|----------------|------------------------|--------|---------------|---------------|-------------------------|--------|---------------|------------------|------------------------|--------|-------------|---------------|-------------------------|--------|
| Beaverhead | Baldy Mountain | Garrett Hill           | 01-092 | Granite       | Moose Lake    | Old Dominion            | 20-180 | Lewis & Clark | Marysville       | Goldral Millsite       | 25-365 | Mineral     | Iron Mountain | Dillon Millsite         | 31-073 |
| Beaverhead | Bannack        | Apex Millsite          | 01-006 | Granite       | Philipsburg   | Bi-Metallic/Old Red     | 20-002 | Lewis & Clark | Orphir           | Victory/Evening Star   | 25-010 | Mineral     | Keystone      | Nancy Lee Mine          | 31-001 |
| Beaverhead | Bannack        | Gold Leaf/Priscilla    | 01-031 | Granite       | Philipsburg   | Douglas Creek Tailings  | 20-003 | Lewis & Clark | Rimini           | Tennile Mine           | 25-005 | Mineral     | Keystone      | Keystone                | 31-074 |
| Beaverhead | Birch Creek    | Indian Queen           | 01-034 | Granite       | Philipsburg   | Algonquin               | 20-005 | Lewis & Clark | Rimini           | Red Water              | 25-007 | Mineral     | Keystone      | Little Anaconda         | 31-077 |
| Beaverhead | Elkhorn-South  | Old Elkhorn            | 01-169 | Granite       | Philipsburg   | Rumsey Mine/Mill        | 20-018 | Lewis & Clark | Rimini           | Valley Forge/Suite     | 25-008 | Mineral     | Keystone      | Hopkins                 | 31-078 |
| Beaverhead | Ermont         | Ermont Mill & Mines    | 01-005 | Granite       | Philipsburg   | Scratch All             | 20-019 | Lewis & Clark | Rimini           | Lower Tennile Millsite | 25-030 | Mineral     | Keystone      | Nancy Lee Millsite      | 31-082 |
| Beaverhead | Hecla          | Silver King            | 01-094 | Granite       | Philipsburg   | Trout                   | 20-062 | Lewis & Clark | Rimini           | Armstrong              | 25-102 | Mineral     | Keystone      | Nancy Lee Mill - Slowey | 31-090 |
| Beaverhead | Hecla          | Lower Cleve            | 01-143 | Granite       | Philipsburg   | Granite Mountain        | 20-110 | Lewis & Clark | Rimini           | Beatrice               | 25-103 | Mineral     | Packer Creek  | Tarbox-Mineral King     | 31-003 |
| Beaverhead | Hecla          | Trapper                | 01-144 | Granite       | Philipsburg   | True Fissure            | 20-111 | Lewis & Clark | Rimini           | Red Mtn. - North & #13 | 25-019 | Mineral     | Packer Creek  | Salteate Consolidate    | 31-021 |
| Beaverhead | Lemhi Pass     | South Frying Pan       | 01-211 | Granite       | South Boulder | Nonpareil               | 20-012 | Lewis & Clark | Rimini           | Upper Valley Forge     | 25-280 | Missoula    | Crammer Creek | Linton                  | 32-017 |
| Beaverhead | Lemhi Pass     | Last Chance No. 1      | 01-216 | Granite       | South Boulder | Brooklyn                | 20-025 | Lewis & Clark | Rimini           | SE SE S13              | 25-294 | Missoula    | Elk Creek     | Morre & Kennedy         | 32-033 |
| Beaverhead | Lemhi Pass     | Last Chance No. 2      | 01-220 | Jefferson     | Alhambra      | Middle Fk. Warm Springs | 22-046 | Lewis & Clark | Scratchgravel    | Franklin               | 25-339 | Missoula    | Ninemile      | Joe Wallit              | 32-010 |
| Beaverhead | Lost Creek     | Tungsten Millsite      | 01-170 | Jefferson     | Alhambra      | Alhambra Hot Springs    | 22-049 | Lewis & Clark | Stemple          | NE NW S13              | 25-197 | Missoula    | Ninemile      | Lost Cabin              | 32-011 |
| Beaverhead | Wisdom         | Clara                  | 01-262 | Jefferson     | Alhambra      | Solar Silver            | 22-054 | Lewis & Clark | Stemple          | Swansea Tailings       | 25-208 | Missoula    | Ninemile      | Nugget                  | 32-042 |
| Beaverhead | Wisdom         | Marin                  | 01-270 | Jefferson     | Basin         | Bullion                 | 22-008 | Lewis & Clark | Stemple          | SE SW S10              | 25-212 | Missoula    | Ninemile      | Haulita                 | 32-057 |
| Broadwater | Confederate    | Miller Mountain        | 04-138 | Jefferson     | Basin         | Basin Millsite          | 22-036 | Lewis & Clark | Stemple          | Pangewasat             | 25-226 | Missoula    | Woodman       | Ward Lode               | 32-005 |
| Broadwater | Confederate    | Hummingbird            | 04-144 | Jefferson     | Basin         | Perry Park              | 22-039 | Lewis & Clark | Stemple          | Astor                  | 25-227 | Missoula    | Woodman       | Upper Triantler         | 32-048 |
| Broadwater | Heligate       | Argo                   | 04-015 | Jefferson     | Basin         | Buckeye                 | 22-072 | Lewis & Clark | Stemple          | Snowshoe               | 27-005 | Missoula    | Woodman       | Mill Creek Mine         | 32-049 |
| Broadwater | Indian Creek   | Park (Marietta)        | 04-012 | Jefferson     | Basin         | Enterprise              | 22-074 | Lincoln       | Libby            | Cherry Creek Millsite  | 27-006 | Park        | Emigrant      | Allison                 | 34-018 |
| Broadwater | Indian Creek   | St. Louis              | 04-013 | Jefferson     | Basin         | Jack Creek Tailings     | 22-296 | Lincoln       | Libby            | Mitchell Creek         | 27-055 | Park        | New World     | McLaren Tailings        | 34-004 |
| Broadwater | Indian Creek   | Diamond Hill           | 04-020 | Jefferson     | Basin         | Marguerite              | 22-301 | Lincoln       | Libby            | Silver Cable           | 27-066 | Park        | New World     | Lower Glegary           | 34-006 |
| Broadwater | Radersburg     | Ohio                   | 04-009 | Jefferson     | Catact        | Mantle (East)           | 22-032 | Madison       | Norris/Red Bluff | Boaz                   | 29-013 | Park        | New World     | Gold Dust               | 34-007 |
| Broadwater | Radersburg     | Keating Tailings       | 04-121 | Jefferson     | Catact        | Crystal                 | 22-073 | Madison       | Norris/Red Bluff | Grabstake              | 29-399 | Park        | New World     | Little Daisy            | 34-009 |
| Broadwater | Winston        | East Pacific           | 04-008 | Jefferson     | Catact        | Eva May                 | 22-075 | Madison       | Norwegian        | Norwegian              | 29-006 | Park        | New World     | McLaren Mine            | 34-010 |
| Broadwater | Winston        | Vosburg                | 04-014 | Jefferson     | Catact        | Morning Glory           | 22-077 | Madison       | Pony             | Atlantic & Pacific     | 29-033 | Park        | New World     | Black Warrior           | 34-079 |
| Cascade    | Hughesville    | Block P Tailings       | 07-090 | Jefferson     | Clancy        | Nellie Grant            | 22-244 | Madison       | Pony             | Boaz Tweed             | 29-034 | Park        | New World     | Upper Alice E.          | 34-085 |
| Cascade    | Hughesville    | Bon Ton                | 07-094 | Jefferson     | Clancy        | General Grant           | 22-245 | Madison       | Pony             | Strawberry             | 29-038 | Park        | New World     | Fisher Creek No. 1      | 34-090 |
| Cascade    | Hughesville    | Galena Ck. Sampling    | 07-090 | Jefferson     | Colorado      | Alta                    | 22-001 | Madison       | Rochester        | Emma                   | 29-061 | Park        | New World     | Homestake No. 2         | 34-093 |
| Cascade    | Neihart        | Vilpa                  | 07-080 | Jefferson     | Colorado      | Bertha                  | 22-002 | Madison       | Rochester        | Thistle No. 1          | 29-073 | Powell      | Elliston      | Charter Oak             | 39-003 |
| Cascade    | Neihart        | Molton                 | 07-084 | Jefferson     | Colorado      | Bluebird                | 22-003 | Madison       | Rochester        | Watson                 | 29-075 | Powell      | Elliston      | Lily/Orphan Boy         | 39-006 |
| Cascade    | Neihart        | Evening Star Millsite  | 07-087 | Jefferson     | Colorado      | Corbin Flats            | 22-004 | Madison       | Sheridan         | Smuggler               | 29-010 | Powell      | Elliston      | Monarch                 | 39-008 |
| Cascade    | Neihart        | Compromise             | 07-100 | Jefferson     | Colorado      | Gregory                 | 22-005 | Madison       | Sheridan         | Goldschmidt-Steiner    | 29-078 | Powell      | Elliston      | Ontario Millsite        | 39-010 |
| Cascade    | Neihart        | Carpenter Ck. Tailings | 07-103 | Jefferson     | Colorado      | Washington              | 22-007 | Madison       | Sheridan         | Red Pine               | 29-079 | Powell      | Elliston      | Golden Anchor           | 39-012 |
| Cascade    | Neihart        | Rochester              | 07-110 | Jefferson     | Colorado      | Argentine               | 22-102 | Madison       | Sheridan         | Broad Gauge            | 29-293 | Powell      | Elliston      | Hard Luck               | 39-014 |
| Cascade    | Neihart        | Silver Belt            | 07-111 | Jefferson     | Colorado      | Minah Mine              | 22-104 | Madison       | Sheridan         | Latest Out             | 29-354 | Powell      | Elliston      | Kimball                 | 39-018 |
| Cascade    | Neihart        | Fairplay               | 07-112 | Jefferson     | Colorado      | Wickes Smelter          | 22-358 | Madison       | Sheridan         | Uncle Sam              | 29-383 | Powell      | Elliston      | Sure Thing              | 39-020 |
| Cascade    | Neihart        | Atlantus               | 07-113 | Jefferson     | Elkhorn       | Elkhorn Queen           | 22-027 | Madison       | Sheridan         | Lakeshore              | 29-436 | Powell      | Elliston      | Julia                   | 39-022 |
| Cascade    | Neihart        | Stallabrams            | 07-120 | Jefferson     | Elkhorn       | Queen (Tourmaline)      | 22-111 | Madison       | Sheridan         | Buckeye                | 29-451 | Powell      | Elliston      | Telegraph Mine          | 39-023 |
| Cascade    | Neihart        | Dacotah                | 07-121 | Jefferson     | Elkhorn       | Tacoma                  | 22-284 | Madison       | Sheridan         | Pedro                  | 29-455 | Powell      | Elliston      | Third Term              | 39-024 |
| Cascade    | Neihart        | Maud S.                | 07-129 | Jefferson     | Elkhorn       | Sourdough               | 22-336 | Madison       | Sheridan         | SE SW S26 (Keynote)    | 29-474 | Powell      | Elliston      | Anna R./Hattie M.       | 39-044 |
| Cascade    | Neihart        | Neihart Tailings       | 07-134 | Jefferson     | High Ore      | Comet Tailings          | 22-009 | Madison       | Sheridan         | NE SE S26              | 29-476 | Powell      | Elliston      | Mountain View           | 39-062 |
| Cascade    | Neihart        | Silver Dike Adit       | 07-135 | Jefferson     | High Ore      | Grey Eagle              | 22-029 | Madison       | Silver Star      | Broadway/Victoria      | 29-179 | Powell      | Elliston      | Viking                  | 39-077 |
| Cascade    | Neihart        | Silver Dyke Tailings   | 07-137 | Judith Basin  | Hughesville   | Block P Mine            | 23-001 | Madison       | South Boulder    | Mammoth                | 29-008 | Powell      | Emery         | Emery                   | 39-004 |
| Cascade    | Neihart        | Silver Dyke Millsite   | 07-138 | Judith Basin  | Hughesville   | Marcelline              | 23-022 | Madison       | South Boulder    | Mammoth Tailings       | 29-082 | Powell      | Orphir        | NE NW S32               | 39-052 |
| Cascade    | Neihart        | Sherman No. 2 - NE     | 07-140 | Judith Basin  | Hughesville   | Belt Patent             | 23-035 | Madison       | Tidal Wave       | B&H                    | 29-083 | Ravalli     | Curlew        | Curlew                  | 41-003 |
| Cascade    | Neihart        | Sherman No. 2 - SW     | 07-142 | Judith Basin  | Hughesville   | Lucky Strike/NE NE S7   | 23-042 | Madison       | Tidal Wave       | Dry Gulch (South)      | 29-282 | Ravalli     | Frog Pond     | Montana Prince          | 41-004 |
| Cascade    | Neihart        | Big Seven              | 07-156 | Judith Basin  | Hughesville   | Wright Lode             | 23-045 | Madison       | Tidal Wave       | Eleanor East           | 29-285 | Ravalli     | Hughes Creek  | Lucky Joe               | 41-027 |
| Cascade    | Neihart        | Baker                  | 07-180 | Judith Basin  | Hughesville   | Edwards Lode            | 23-046 | Madison       | Tidal Wave       | Pete & Joe             | 29-449 | Ravalli     | Pleasant View | Blue Bird               | 41-009 |
| Deer Lodge | Orofino        | Champion               | 12-003 | Judith Basin  | Hughesville   | Harrison/Moulton        | 23-056 | Madison       | Tidal Wave       | Ohio                   | 29-473 | Sanders     | Blue Creek    | Broken Hill             | 45-005 |
| Deer Lodge | Silver Lake    | Cable                  | 12-002 | Judith Basin  | Hughesville   | Moulton                 | 23-058 | Madison       | Tidal Wave       | Kearage                | 29-102 | Sanders     | Plains        | Montro Gold             | 45-010 |
| Deer Lodge | Silver Lake    | Gold Coin Mine         | 12-004 | Judith Basin  | Hughesville   | Tiger                   | 23-059 | Madison       | Virginia City    | General Shafter        | 29-103 | Sanders     | Plains        | Dee Creek               | 45-041 |
| Deer Lodge | Silver Lake    | Silver Lake Millsite   | 12-070 | Judith Basin  | Hughesville   | Vortex                  | 23-027 | Madison       | Virginia City    | Apex                   | 29-105 | Sanders     | Plains        | Lower Letterman         | 45-047 |
| Fergus     | Warm Springs   | Tail Holt              | 14-010 | Judith Basin  | Yogo          | NE NE S31               | 23-079 | Madison       | Virginia City    | JTC                    | 29-106 | Sanders     | Trout Creek   | Holiday (Silver Mark)   | 45-009 |
| Fergus     | Warm Springs   | Cumberland             | 14-017 | Lewis & Clark | Helena        | Davis Gulch II          | 25-040 | Madison       | Virginia City    | Pacific                | 29-118 | Sanders     | White Pine    | Jack Waite              | 45-002 |
| Flathead   | Hog Heaven     | Flathead Mine          | 15-012 | Lewis & Clark | Helena        | Spring Hill Tailings    | 25-067 | Madison       | Virginia City    | Easton                 | 29-121 | Silver Bow  | Basin Creek   | Highland Mine           | 47-028 |
| Gallatin   | Bozeman        | Elk Creek Conundrum    | 16-013 | Lewis & Clark | Helena        | Lady Luck               | 25-073 | Madison       | Washington       | Missouri               | 29-373 | Silver Bow  | Elk Park      | Mary Emmee/Clinton      | 47-035 |
| Gallatin   | Bozeman        | Thumper Mica           | 16-015 | Lewis & Clark | Helena        | Mother Lode             | 25-363 | Madison       | Washington       | SE SE S25              | 29-394 | Silver Bow  | Elk Park      | Rising Sun              | 47-037 |
| Gallatin   | Bozeman        | Karat Asbestos         | 16-018 | Lewis & Clark | Lincoln       | Seven-Up Pete/Rover     | 25-020 | Meagher       | Beaver Creek     | SE NW S24              | 30-017 | Silver Bow  | Melrose       | Old Glory               | 47-027 |
| Granite    | Alpa           | Alpa                   | 20-065 | Lewis & Clark | Lincoln       | Blackfoot Tailings      | 25-322 | Meagher       | Beaver Creek     | Lane                   | 30-019 | Silver Bow  | Melrose       | Chipper                 | 47-029 |
| Granite    | Antelope Creek | Silver King            | 20-186 | Lewis & Clark | Lincoln       | Bald Mountain           | 25-061 | Meagher       | Beaver Creek     | Bigler                 | 30-067 | Silver Bow  | Melrose       | Maiden Rock             | 47-051 |
| Granite    | Antelope Creek | Lori No. 13            | 20-191 | Lewis & Clark | Marysville    | Big Ox Millsite         | 25-115 | Meagher       | Beaver Creek     | Porcupine              | 30-069 | Silver Bow  | Moose Creek   | Middle Fork Millsite    | 47-081 |
| Granite    | Antelope Creek | Ant                    | 20-194 | Lewis & Clark | Marysville    | Big Ox Mine             | 25-116 | Meagher       | Beaver Creek     | Cumberland             | 30-004 | Stillwater  | Nye           | Mount Mine              | 48-001 |
| Granite    | Combination    | Combination            | 20-009 | Lewis & Clark | Marysville    | Belmont                 | 25-167 | Meagher       | Beaver Creek     | Castle Mtn.            | 30-007 | Stillwater  | Stillwater    | Benbow Millsite         | 48-005 |
| Granite    | Dunkleburg     | Forest Rose            | 20-004 | Lewis & Clark | Marysville    | Piegan/Gloster Millsite | 25-172 | Meagher       | Beaver Creek     | Belle of the Castle    | 30-007 | Sweet Grass | Independence  | Poorman/Emma            | 49-001 |
| Granite    | Dunkleburg     | Wasa                   | 20-023 | Lewis & Clark | Marysville    | Empire Millsite         | 25-175 | Mineral       | Cedar Creek      | SW NE S10              | 30-078 | Sweet Grass | Independence  | Yager/Daisy             | 49-002 |
| Granite    | Dunkleburg     | Jackson Park           | 20-027 | Lewis & Clark | Marysville    | Bald Butte Millsite     | 25-179 | Mineral       | Iron Mountain    | Iron Mountain Millsite | 31-010 | Sweet Grass | Independence  | NW SE S22               | 49-003 |
| Granite    | Maxville       | Maxville Tailings      | 20-209 | Lewis & Clark | Marysville    | Argo Millsite           | 25-314 | Mineral       | Iron Mountain    | Gold King              | 31-067 |             |               |                         |        |
| Granite    | Moose Lake     | Banner                 | 20-175 | Lewis & Clark | Marysville    | Wildcat                 | 25-317 | Mineral       | Iron Mountain    | Belle of the Hills     | 31-072 |             |               |                         |        |

TABLE 1-1: ABANDONED HARDROCK MINE PRIORITY SITES LIST



## 1.2 PROJECT DESCRIPTION

The 270 priority sites investigated under the Abandoned Mines Hazardous Materials Inventory were located in 23 counties and in 86 out of the 206 mining districts in Montana. Site investigations began May 18, 1993, and were completed on September 20, 1993. Two field crews, each consisting of three scientists and technicians, were in the field for approximately 95 days to complete the data collection effort.

The site investigation conducted at each site involved the following tasks: overall site reconnaissance; mapping; collection of tailings, slag, waste rock, adit discharge, flooded shafts, stream water, and sediment samples; field analysis of solid matrix samples using an X-ray Fluorescence (XRF) Spectrometer; and measurements of field parameters in water, including flow rates, pH, specific conductance, temperature, oxidation reduction potential, and alkalinity. The field team members also photographed sample locations and significant site features, video taped the site, and evaluated safety hazards.

The period during which the field investigations were conducted was abnormally wet. There were 69 days of measurable precipitation with a total accumulation of 11.2 inches (measured at Butte, Montana). This compared to a 40-year average accumulation of 6.4 inches for the same period and location. The above-average amount of precipitation may have resulted in higher than normal stream flows and documentation of increased storm runoff events and releases to surface water than would normally be expected. The abnormally high level of precipitation may also have led to an abnormally low number of observed releases to air via blowing dust from the waste sources.

The physical setting and topography associated with these sites ranged from gently sloping land in valley bottoms to very steep, high elevation, mountainous areas. Access to sites was often difficult due to poor road conditions or absence of maintained roads. Access to several sites was limited to travel on foot or by helicopter. Ownership of the priority sites is a mix of public lands (U.S. Department of Agriculture/Forest Service, U.S. Department of Interior/Bureau of Land Management, Montana Department of State Lands, etc.) and patented lands (private ownership). The priority sites consist of primarily inactive/abandoned mine sites; however, exploration activities were in progress at several of the sites.



Significant features at the sites included tailings ponds, impoundments, and piles; waste rock dumps or piles; mine openings, including adits, shafts, glory holes, and exploration trenches; miscellaneous buildings and structures; and roads. Mine opening discharges and streams adjacent to or flowing through the sites were common.

Hazardous materials observed at some of the sites included chemical reagents, solvents, asbestos-containing material, petroleum fuels or lubricating oils storage (barrels or tanks) and miscellaneous power supply items (poles, transformers, lines, etc.). Some of the sites support wildlife, domestic grazing, or aquatic life. Residential occupation of the sites was observed in rare cases, but residences adjacent to the sites occurred more frequently.

### 1.3 SUMMARY OF FINDINGS

The following information is provided as an overview of the data compiled during the Hazardous Materials Inventory.

#### Laboratory Sampling

- Total number of lab samples: 1,554 (does not include the QA/QC duplicates), representing approximately 34,200 data points generated by the laboratories.
- Total number of XRF samples: 3,082 (does not include the QA/QC duplicates), representing approximately 64,700 data points.

#### Waste Rock Associated with the Priority Sites

- Estimated total volume: 6,481,000 cubic yards.
- Estimated total area: 14,470,000 square feet (332 acres).
- Estimated total unvegetated/uncovered area: 13,405,000 square feet (307 acres).

#### Mill Tailings Associated with the Priority Sites

- Estimated total volume: 7,952,000 cubic yards.
- Estimated total area: 18,653,000 square feet (428 acres).
- Estimated unvegetated/uncovered area: 12,718,000 square feet (292 acres).

#### Adit Discharges Associated with the Priority Sites

- Total number of discharging adits: 151.
- Number of adit discharges with pH  $\leq$  5.00: 23.
- Number of adit discharges with pH  $\leq$  6.00: 34.

#### Flooded Shafts Associated with the Priority Sites

- Total number of open shafts with water: 9.
- Shafts with pH  $\leq$  5.00: 3.

#### Water Quality Criteria

- Number of discharges exceeding Safe Drinking Water Act MCL/MCLGs: 65.  
60 adits  
5 shafts
- Number of adit discharges exceeding acute aquatic life criteria: 76.
- Number of observed releases to surface water: 120.





## 2.0 INVESTIGATION METHODS

### 2.1 DATABASE AND LITERATURE SEARCH

Data collected in the field was supplemented by an extensive literature search and the use of several computer databases. This supplemental information was used to complete the inventory forms and fulfill receptor information requirements for the AIMSS. The computer databases used to collect this information were:

- The Montana Bureau of Mines and Geology (MBMG) Well Logs Database, which was compiled by the MGMB and the DNRC. This database was used to estimate the number of wells within a one- and four-mile radius of each site.
- The Montana Rivers Information System (MRIS), Version 2.0, compiled by the Montana State Library for the Montana Department of Fish, Wildlife and Parks. This database was used to assign classifications relating to riparian habitat quality, wetlands frontage, fisheries habitat and species classification, and sport fisheries classification for stream reaches potentially impacted by each site, where applicable.
- The Montana Department of Health and Environmental Sciences, Water Quality Bureau (DHES-WQB) - Community Water Supplies Database. The DHES-WQB provided a list of surface water resources presently used for drinking water supplies in Montana.

Additional information was obtained from the following sources:

- Peak and average stream flow estimates were obtained from USGS flow monitoring reports on gaged streams.
- Population estimates were obtained by counting buildings delineated on the USGS quadrangle maps and USFS Forest Visitors Maps. Field observations supplemented this source of information.

- Historic mine/millsite operations, mineralogy, and geology were obtained from several sources, including: USBM Circulars, USGS Bulletins and Professional Papers, and MBMG Memoirs, Bulletins, and Circulars.
- Historic analytical data were obtained from the DSL-AMRB project files, the DHES-SHWB project files, the DHES-WQB, USFS project files, and MBMG data collected for the USFS. This data was reviewed prior to site visits to provide the investigators with background information on potential hazards associated with each site.

## 2.2 FIELD METHODS

A detailed discussion of specific investigation methodologies is found in the DSL-AMRB Hazardous Materials Inventory Sampling and Analysis Plan (SAP), (Pioneer, 1993a). The purpose of this section is to describe some of the unique details of the investigative methods used to fulfill the project objectives.

The first task in undertaking consistent evaluation of 270 sites was the development of an inventory form that would serve as a field sampling plan to ensure that the necessary pertinent data was collected for each site. The inventory form was used during the investigation to guide and focus the investigative tasks. Literature searches and database searches were performed prior to the field investigations to provide investigators with background information on each site.

Sampling was performed on waste rock dumps, mill tailings, streams, ponds, adit discharges, flooded shafts, and from domestic groundwater wells or monitoring wells, when present.

Each tailing's feature was characterized both spatially and vertically by hand-auguring to determine accurate depths and delineate stratification or differences in metals concentrations between the upper oxidized zone(s) and the lower reduced zones. Subsamples were collected from each visually different strata.

Typically, several subsamples were collected from each waste rock dump in order to better characterize very heterogeneous waste sources.

Subsamples from the tailings and waste rock were analyzed in the field using X-ray Fluorescence (XRF) Spectrometers. The field screening data allowed the investigators to make informed decisions on the number of samples required for laboratory analyses and indicated how best to composite the subsamples from the potential sources in order to send representative samples to the laboratory, while minimizing the number of samples to achieve this end. The XRF analyses also provided an increased number of valid and discrete data points per site achieving a more thorough understanding of the problems associated with each site. Solids were characterized additionally by measurement of pH and radioactivity.

Stream sediment samples were also analyzed in the field with the XRF in order to assist in the assessment the extent of contamination and migration from the waste sources.

Surface water sampling was often conducted so as to characterize impacts to drainage basins, as well as contributions from individual sites, when multiple sources were present. Waters were additionally characterized in the field by measuring flow rates, pH, specific conductance, oxidation/reduction potential, and temperature.

Site mapping was conducted using standard "Chain and Compass" surveying techniques. The primary purpose of mapping was to estimate volume and area of waste sources and record sample locations. Other significant site features, such as streams or drainages, roads, mine openings, and structures, were also recorded on the site sketches. Sample locations and other significant site features were documented on photographic slides and video tape to assist the resource managers in their evaluation of the priority sites.





### 3.0 DATA EVALUATION AND COMPARISONS

The purpose of this section is to discuss data quality validation and evaluations, as well as comparisons of the data to pertinent criteria.

#### 3.1 DATA VALIDATION AND EVALUATION

##### 3.1.1 Laboratory Data Validation and Evaluation

The laboratory utilized during this investigation complied all of the QA/QC performance requirements as defined in the Contract Laboratory Program (CLP) Statement of Work (SOW, March 1990). The data packages provided by the laboratory allowed comprehensive data validation and evaluation procedures to be accomplished. Overall laboratory data validation/evaluation was performed according to guidelines developed by the U.S. Environmental Protection Agency (EPA).

The laboratory data were validated according to the document Laboratory Data Validation Functional Guidelines for Evaluating Inorganics (EPA 1988). The data validation procedures were performed partially by laboratory chemists and partially by a data reviewer from Pioneer Technical Services, Inc. The data validation procedure included an evaluation of the following:

- holding times;
- initial and continuing calibrations;
- calibration and preparation blanks;
- inductively coupled plasma (ICP) interference check samples;
- laboratory control samples (LCS);
- laboratory duplicate sample analyses (precision assessment);
- matrix spike sample analyses (accuracy assessment);
- furnace atomic absorption (AA) quality control (QC);
- Inductively Coupled Plasma (ICP) serial dilutions;
- sample result verification;
- field duplicate analyses (precision assessment);
- field blank analyses; and
- overall assessment of data for the case.

Data evaluation occurred after the data validation process was completed and the qualifiers had been applied to the data. The data evaluation process involved a statistical analysis of the data to identify outliers and assess the quality of the data overall. Data evaluation was performed on the laboratory data which met the Data Quality Objectives (DQOs) outlined in the Final QAPJP for the Abandoned Mines Hazardous Materials Inventory (Pioneer, 1993b).

Although numerous qualifications (flags) were applied to the laboratory data compiled during this investigation, and a small portion of the data were evaluated as outliers, none of the data were flagged "R" or were otherwise considered unusable. Consequently, 100 percent of the laboratory data (soil and water) compiled during this investigation are considered valid and useable for all of the objectives of this project.

The limitations of the data compiled during this investigation should be considered when making interpretations. Please refer to the document entitled Data Validation and Evaluation Report for the Abandoned Mines Hazardous Materials Inventory for a detailed description of the procedures followed and results provided by the overall data assessments.

### 3.1.2 X-Ray Fluorescence Spectrometer Data Validation

Data provided by the field portable XRF Spectrometer were also validated; the XRF data were validated according to manufacturer specifications. Additionally, XRF data were compared to laboratory data to assess precision, correlation, and overall usability.

After data provided by the XRF Spectrometer were statistically compared to laboratory data, 7 out of the 12 XRF analytes were determined to be fully useable at the same level as the laboratory data. These elements were arsenic, antimony, barium, iron, manganese, lead, and zinc. Five out of the 12 XRF analytes were screened out as being unusable based on lack of correlation and poor overall precision. These elements were copper, cadmium, chromium, cobalt, and mercury.



### 3.1.3 Other Field Measurements

Field parameter measurements, such as pH, Eh, and specific conductance, were not evaluated for data quality. Standard operating procedures (Pioneer, 1993a) were carefully followed in the field to achieve a consistent and acceptable level of quality.

## 3.2 DATA INTERPRETATION

The analytical data collected was compared to site-specific background or upgradient concentrations, as well as drinking water standards and aquatic life criteria. The following sections explain how these comparisons were made.

### 3.2.1 Background Soil Comparison

Background soil samples were collected to establish the extent to which metals concentrations were elevated in comparison to the local background. Background samples were typically applied to groups of sites in close proximity to one another and within similar geologic units.

### 3.2.2 Observed Releases to Groundwater, Surface Water, and Sediment

An observed release to surface water is defined as a downstream surface water or stream sediment concentration at more than three times the upstream surface water or sediment concentration, for any constituent that can be attributed to the site. Groundwater, surface water, and stream sediment analytical data was used to document observed releases from the priority sites.

### 3.2.3 MCL/MCLG, Aquatic Life Criteria Comparisons

Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs) are drinking water standards promulgated under the federal Safe Drinking Water Act (SDWA), (40 CFR Parts 141, 143). MCLs and MCLGs apply to public water systems; however, they may be relevant and appropriate to surface or groundwater if those waters

are used as drinking water. Groundwater and surface water metals concentrations observed in samples collected were evaluated against these standards. The current SDWA MCLs and MCLGs expressed in micrograms per liter (ug/L) are:

|                    |                    |                 |
|--------------------|--------------------|-----------------|
| Arsenic: 50 ug/L   | Barium: 2,000 ug/L | Cadmium: 5 ug/L |
| Copper: 1,300 ug/L | Chromium: 100 ug/L | Mercury: 2 ug/L |
| Nickel: 100 ug/L   | Antimony: 6 ug/L   | Lead: 15 ug/L   |
| Cyanide: 200 ug/L  |                    |                 |

Surface water and mine discharge analytical results were also evaluated against the freshwater acute and chronic aquatic life criteria as presented in the Montana Numeric Water Quality Standards, Circular WQB-7. These criteria are expressed as a function of total hardness and were corrected for the hardness measured in each sample.

### 3.3 DATA MANAGEMENT

The data collected under this project has been input into the data manager dBase IV, Version 2.0. Four files were created to contain the data and aid in any manipulation of the data that may be desired. These files are summarized briefly below.

- PTSDATA.DBF contains field data collected for each sample during the Hazardous Materials Inventory;
- XRFDATA.DBF contains the analyses done by the field XRF data generated during the Hazardous Materials Inventory;
- LABDATA.DBF contains the data from all of the laboratory analyses performed during the Hazardous Materials Inventory; and
- PRIORITY.DBF is the modified dBase file provided to Pioneer by DSL-AMRB from the master inventory.

The information from these four files can be readily combined with one another to form a relational database.

## 4.0 SITE RANKING

The final task of the Hazardous Materials Inventory involved the development of a system to rank the severity of hazards or environmental threats associated with the sites investigated in order to assist the DSL-AMRB in prioritizing reclamation efforts and allocation of resources. This system, the Abandoned and Inactive Mines Scoring System (AIMSS), closely follows the EPA's Hazard Ranking System, although the AIMSS is specifically focused on potential hazards typically associated with the abandoned or inactive hardrock mines.

The AIMSS also evaluated potential safety hazards associated with the sites such as hazardous mine openings, high-walls, and structures, and generated a separate safety score for each site. The AIMSS utilized the data collected for each site to assign a ranking score.

The AIMSS is focused towards the physical site setting and potential hazards associated with abandoned and inactive mines due to its capability to evaluate mine opening discharges and large quantities of mine wastes. The AIMSS scoring method evaluates relative risks between sites. This accounts for site-specific contaminant concentrations and the varying toxicity of different constituents, as well as adit discharges in the source evaluation. This method more effectively discriminates between sites with higher concentrations or more toxic constituents in relation to sites with lower concentrations or less toxic constituents. In order to generate an overall Mine Site Human Health and Environmental Hazard Score, the AIMSS evaluates the groundwater pathway, surface water pathway, air pathway, and direct contact pathway. Under each pathway, the AIMSS evaluates observed releases, potential to release, pathway characteristics, waste characteristics, and targets.

Table 4-1 lists the priority sites and their associated AIMSS score, sorted in descending order. Seven of the 270 sites on the priority list were not ranked due to complications associated with collecting the necessary data. Three of these sites were inactive or abandoned when originally inventoried, but since then have become active mining or milling operations. Because these sites are currently active, ranking and evaluation are difficult due to continually changing site conditions. These sites were the Watseca Mill, the Cable Mine, and the Maiden Rock Mine. Two of the sites, the Silver Cable and the



| SITE RANK | SITE NAME                   | COUNTY        | PA No. | AIMSS SCORE |
|-----------|-----------------------------|---------------|--------|-------------|
| 1         | Corbin Flats                | Jefferson     | 22-004 | 4080.59     |
| 2         | Red Mtn. - North & #13      | Lewis & Clark | 25-018 | 1628.48     |
| 3         | Emery                       | Powell        | 38-004 | 878.82      |
| 4         | Red Water                   | Lewis & Clark | 25-007 | 859.17      |
| 5         | Curlew                      | Rescue        | 41-003 | 825.00      |
| 6         | Block P Tailings            | Cascade       | 07-000 | 536.80      |
| 7         | Peguin/Glacier Mide         | Lewis & Clark | 25-172 | 516.81      |
| 8         | Connet Tailings             | Jefferson     | 22-009 | 510.15      |
| 9         | Chatter Oak                 | Powell        | 38-003 | 480.48      |
| 10        | Spring Hill Tailings        | Lewis & Clark | 25-007 | 458.20      |
| 11        | Douglas Creek Tailings      | Jefferson     | 20-003 | 347.96      |
| 12        | Block P Mine                | Judith Basin  | 23-001 | 326.17      |
| 13        | Vauborg                     | Broadwater    | 04-014 | 265.31      |
| 14        | Ala                         | Jefferson     | 22-001 | 262.52      |
| 15        | Scratch A8                  | Granite       | 20-019 | 250.58      |
| 16        | Washington                  | Jefferson     | 22-007 | 250.25      |
| 17        | Enterprise                  | Jefferson     | 22-074 | 245.76      |
| 18        | Park (Marietta)             | Broadwater    | 04-012 | 240.40      |
| 19        | Empire Mide                 | Lewis & Clark | 25-175 | 240.27      |
| 20        | Crystal                     | Jefferson     | 22-077 | 238.68      |
| 21        | Fairhead Mine               | Fairhead      | 15-012 | 180.73      |
| 22        | Golden Mide                 | Lewis & Clark | 25-365 | 180.51      |
| 23        | Nancy Lee Mill - Stowey     | Mineral       | 31-080 | 175.41      |
| 24        | East Pacific                | Broadwater    | 04-008 | 168.32      |
| 25        | Silver Dixie Adit           | Cascade       | 07-135 | 160.86      |
| 26        | Edwards Lode                | Judith Basin  | 23-048 | 152.66      |
| 27        | Nellis Grant                | Jefferson     | 22-244 | 135.64      |
| 28        | Combination                 | Granite       | 20-008 | 127.02      |
| 29        | Valley Forge/Suile          | Lewis & Clark | 25-008 | 126.03      |
| 30        | Armstrong                   | Lewis & Clark | 25-102 | 108.50      |
| 31        | Carpenter Ck. Tailings      | Cascade       | 07-103 | 103.53      |
| 32        | Bulfin                      | Jefferson     | 22-008 | 99.48       |
| 33        | Highland Mine               | Silver Bow    | 47-028 | 97.74       |
| 34        | Lower Tennis Mide           | Lewis & Clark | 25-050 | 97.38       |
| 35        | Franklin                    | Lewis & Clark | 25-339 | 86.58       |
| 36        | Tennille                    | Lewis & Clark | 25-005 | 79.90       |
| 37        | Boaz                        | Madison       | 20-013 | 78.47       |
| 38        | Cambrian                    | Meagher       | 30-004 | 78.22       |
| 39        | Nancy Lee Mide              | Mineral       | 31-062 | 73.28       |
| 40        | Upper Valley Forge          | Lewis & Clark | 25-280 | 72.21       |
| 41        | Snowshoe                    | Livonia       | 27-005 | 69.38       |
| 42        | Sher Dyke Tailings          | Cascade       | 07-137 | 68.15       |
| 43        | Maxwell Tails (Londonberry) | Granite       | 20-208 | 65.54       |
| 44        | Bald Butte Mide             | Lewis & Clark | 25-178 | 60.59       |
| 45        | Trout                       | Granite       | 20-062 | 57.60       |
| 46        | Buckeye                     | Jefferson     | 22-072 | 55.45       |
| 47        | Bl-Metallic/Red             | Granite       | 20-002 | 52.20       |
| 48        | Livonia                     | Missoula      | 32-017 | 49.35       |
| 49        | Gregory                     | Jefferson     | 22-005 | 47.21       |
| 50        | Thiela No. 1                | Madison       | 28-073 | 47.02       |
| 51        | Middle Pt. Warm Springs     | Jefferson     | 22-046 | 46.31       |
| 52        | Mary Emme/Canton            | Silver Bow    | 47-035 | 43.53       |
| 53        | Erment Mill & Mines         | Broadwater    | 01-005 | 41.98       |
| 54        | Montro Gold                 | Sanders       | 45-010 | 39.91       |
| 55        | Granite Mountain            | Granite       | 20-110 | 38.66       |
| 56        | Buckeye                     | Madison       | 29-451 | 37.81       |
| 57        | Nelltail Tailings           | Cascade       | 07-134 | 37.58       |
| 58        | Bluebird                    | Jefferson     | 22-003 | 32.47       |
| 59        | Forest Rose                 | Granite       | 20-004 | 30.87       |
| 60        | Mammoth Tailings            | Madison       | 28-082 | 30.58       |
| 61        | Lily/Organ Boy              | Powell        | 38-006 | 29.39       |
| 62        | Wright Lode                 | Judith Basin  | 23-045 | 29.30       |
| 63        | SE SW S26 (Keynote)         | Madison       | 28-474 | 28.44       |
| 64        | Sher Dyke Mide              | Cascade       | 07-138 | 26.33       |
| 65        | Brooklyn                    | Granite       | 20-025 | 27.21       |
| 66        | Harrisford/Idation          | Judith Basin  | 23-056 | 27.04       |
| 67        | Missouri                    | Madison       | 28-373 | 24.42       |
| 68        | Dacotha                     | Cascade       | 07-121 | 22.91       |

| SITE RANK | SITE NAME            | COUNTY        | PA No. | AIMSS SCORE |
|-----------|----------------------|---------------|--------|-------------|
| 69        | Bertha               | Jefferson     | 01-001 | 21.92       |
| 70        | Gold Leaf/Prichella  | Broadwater    | 22-021 | 20.66       |
| 71        | Gold Coin Mine       | Deer Lodge    | 12-004 | 17.50       |
| 72        | Kant Abostoon        | Gallatin      | 16-018 | 17.34       |
| 73        | Agoguan              | Granite       | 20-005 | 16.12       |
| 74        | Big Ox Mide          | Lewis & Clark | 25-115 | 16.04       |
| 75        | Broadway/Victoria    | Madison       | 28-178 | 15.53       |
| 76        | Ward Lode            | Missoula      | 32-005 | 14.72       |
| 77        | Broken Hill          | Sanders       | 45-005 | 13.90       |
| 78        | NE NW S13            | Lewis & Clark | 25-197 | 13.86       |
| 79        | Cherry Creek Mide    | Powell        | 38-010 | 13.63       |
| 80        | Marmoth              | Madison       | 29-008 | 12.82       |
| 81        | Blackbird Tailings   | Lewis & Clark | 25-322 | 12.57       |
| 82        | Argentine            | Jefferson     | 22-111 | 11.36       |
| 83        | Sure Thing           | Powell        | 38-020 | 10.58       |
| 84        | True Fissure         | Granite       | 20-111 | 10.57       |
| 85        | Eva May              | Jefferson     | 22-075 | 10.15       |
| 86        | Old Elkhorn          | Broadwater    | 01-169 | 8.81        |
| 87        | Norquay              | Granite       | 20-012 | 7.75        |
| 88        | Queen (Tourmaline)   | Jefferson     | 23-059 | 7.74        |
| 89        | Tiger                | Judith Basin  | 22-027 | 7.51        |
| 90        | Elkhorn Queen        | Jefferson     | 25-081 | 7.00        |
| 91        | Bald Mountain        | Lewis & Clark | 25-081 | 7.00        |
| 92        | Pacific              | Madison       | 28-118 | 6.82        |
| 93        | Evening Star Mide    | Cascade       | 07-007 | 6.42        |
| 94        | Lower Glenary        | Park          | 34-006 | 6.23        |
| 95        | Dillon Mide          | Mineral       | 31-073 | 6.10        |
| 96        | Boss Tweed           | Madison       | 28-034 | 6.05        |
| 97        | Black Warrior        | Park          | 34-078 | 6.04        |
| 98        | Lower Cleve          | Broadwater    | 01-143 | 5.98        |
| 99        | Big Seven            | Cascade       | 07-156 | 5.98        |
| 100       | Beatrice             | Lewis & Clark | 25-103 | 5.47        |
| 101       | St. Louis            | Broadwater    | 04-013 | 5.34        |
| 102       | McLaren Tailings     | Park          | 34-004 | 5.24        |
| 103       | Keating Tailings     | Jefferson     | 22-026 | 4.75        |
| 104       | Grey Eagle           | Granite       | 20-168 | 4.36        |
| 105       | Silver King          | Madison       | 28-039 | 4.32        |
| 106       | Strawberry           | Madison       | 28-436 | 4.08        |
| 107       | Lakeshore            | Mineral       | 31-010 | 4.07        |
| 108       | Iron Mountain Mide   | Cascade       | 07-111 | 4.00        |
| 109       | Sher Bell            | Jefferson     | 22-038 | 3.88        |
| 110       | Basin Mide           | Powell        | 39-022 | 3.68        |
| 111       | Jula                 | Broadwater    | 01-006 | 3.75        |
| 112       | Apex Mide            | Madison       | 28-383 | 3.42        |
| 113       | Uncle Sam            | Madison       | 07-084 | 3.30        |
| 114       | Molton               | Lewis & Clark | 25-208 | 3.28        |
| 115       | Swansea Tailings     | Park          | 37-012 | 2.78        |
| 116       | McLaren Mine         | Sanders       | 45-002 | 2.68        |
| 117       | Fairplay             | Broadwater    | 04-009 | 2.64        |
| 118       | Jack Walle           | Jefferson     | 30-076 | 2.53        |
| 119       | Ohio                 | Madison       | 22-336 | 2.38        |
| 120       | Anna R/Hattie M.     | Jefferson     | 29-354 | 2.19        |
| 121       | SW NE S10            | Madison       | 22-077 | 2.13        |
| 122       | Sourough             | Broadwater    | 01-170 | 2.11        |
| 123       | Boon Ton             | Jefferson     | 31-001 | 2.04        |
| 124       | Latent Ore           | Granite       | 25-227 | 2.02        |
| 125       | Moning Glory         | Lewis & Clark | 47-081 | 1.98        |
| 126       | Nancy Lee Mine       | Silver Bow    | 47-037 | 1.95        |
| 127       | Tungsten Mide        | Jefferson     | 22-054 | 1.91        |
| 128       | Angley Lee Mine      | Madison       | 01-034 | 1.84        |
| 129       | Adair                | Broadwater    | 22-476 | 1.79        |
| 130       | Middle Fork Mide     | Jefferson     | 22-054 | 1.91        |
| 131       | Rising Sun           | Jefferson     | 22-054 | 1.91        |
| 132       | Solar Shier          | Jefferson     | 22-054 | 1.91        |
| 133       | Altamora Hot Springs | Jefferson     | 22-054 | 1.91        |
| 134       | Indian Queen         | Jefferson     | 22-054 | 1.91        |
| 135       | NE SE S26            | Madison       | 22-476 | 1.79        |

| SITE RANK | SITE NAME            | COUNTY        | PA No. | AIMSS SCORE |
|-----------|----------------------|---------------|--------|-------------|
| 205       | Victory/Evening Star | Lewis & Clark | 25-010 | 0.120       |
| 206       | Telegraph Mine       | Meagher       | 30-023 | 0.120       |
| 207       | Bipar                | Madison       | 28-105 | 0.110       |
| 208       | Apex                 | Park          | 34-085 | 0.080       |
| 209       | Upper Alice E.       | Granite       | 20-104 | 0.080       |
| 210       | Art                  | Powell        | 38-024 | 0.080       |
| 211       | Mordana Prince       | Granite       | 20-180 | 0.080       |
| 212       | Third Term           | Granite       | 30-077 | 0.080       |
| 213       | Old Dominion         | Meagher       | 30-007 | 0.080       |
| 214       | Bells Of the Castle  | Broadwater    | 01-084 | 0.050       |
| 215       | Silver King          | Sanders       | 45-047 | 0.050       |
| 216       | Lower Letterman      | Mineral       | 31-078 | 0.040       |
| 217       | Vilpa                | Madison       | 04-144 | 0.030       |
| 218       | Hopkins              | Madison       | 28-103 | 0.030       |
| 219       | Hammigbird           | Powell        | 38-077 | 0.030       |
| 220       | General Shafter      | Jefferson     | 01-220 | 0.020       |
| 221       | Viking               | Sanders       | 45-041 | 0.020       |
| 222       | Baker                | Madison       | 01-216 | 0.020       |
| 223       | Last Chance No. 2    | Missoula      | 32-048 | 0.020       |
| 224       | Deer Creek           | Granite       | 20-181 | 0.010       |
| 225       | Last Chance No. 1    | Missoula      | 32-033 | 0.010       |
| 226       | Upper Triangler      | Jefferson     | 01-211 | 0.010       |
| 227       | Keystone             | Madison       | 22-301 | 0.010       |
| 228       | Madison              | Madison       | 22-057 | 0.010       |
| 229       | Madison              | Madison       | 22-008 | 0.010       |
| 230       | Madison              | Madison       | 22-008 | 0.010       |
| 231       | Madison              | Madison       | 22-008 | 0.010       |
| 232       | Madison              | Madison       | 22-008 | 0.010       |
| 233       | Madison              | Madison       | 22-008 | 0.010       |
| 234       | Madison              | Madison       | 22-008 | 0.010       |
| 235       | Madison              | Madison       | 22-008 | 0.010       |
| 236       | Madison              | Madison       | 22-008 | 0.010       |
| 237       | Madison              | Madison       | 22-008 | 0.010       |
| 238       | Madison              | Madison       | 22-008 | 0.010       |
| 239       | Madison              | Madison       | 22-008 | 0.010       |
| 240       | Madison              | Madison       | 22-008 | 0.010       |
| 241       | Madison              | Madison       | 22-008 | 0.010       |
| 242       | Madison              | Madison       | 22-008 | 0.010       |
| 243       | Madison              | Madison       | 22-008 | 0.010       |
| 244       | Madison              | Madison       | 22-008 | 0.010       |
| 245       | Madison              | Madison       | 22-008 | 0.010       |
| 246       | Madison              | Madison       | 22-008 | 0.010       |
| 247       | Madison              | Madison       | 22-008 | 0.010       |
| 248       | Madison              | Madison       | 22-008 | 0.010       |
| 249       | Madison              | Madison       | 22-008 | 0.010       |
| 250       | Madison              | Madison       | 22-008 | 0.010       |
| 251       | Madison              | Madison       | 22-008 | 0.010       |
| 252       | Madison              | Madison       | 22-008 | 0.010       |
| 253       | Madison              | Madison       | 22-008 | 0.010       |
| 254       | Madison              | Madison       | 22-008 | 0.010       |
| 255       | Madison              | Madison       | 22-008 | 0.010       |
| 256       | Madison              | Madison       | 22-008 | 0.010       |
| 257       | Madison              | Madison       | 22-008 | 0.010       |
| 258       | Madison              | Madison       | 22-008 | 0.010       |
| 259       | Madison              | Madison       | 22-008 | 0.010       |
| 260       | Madison              | Madison       | 22-008 | 0.010       |
| 261       | Madison              | Madison       | 22-008 | 0.010       |
| 262       | Madison              | Madison       | 22-008 | 0.010       |
| 263       | Madison              | Madison       | 22-008 | 0.010       |
| 264       | Madison              | Madison       | 22-008 | 0.010       |
| 265       | Madison              | Madison       | 22-008 | 0.010       |
| 266       | Madison              | Madison       | 22-008 | 0.010       |
| 267       | Madison              | Madison       | 22-008 | 0.010       |
| 268       | Madison              | Madison       | 22-008 | 0.010       |
| 269       | Madison              | Madison       | 22-008 | 0.010       |
| 270       | Madison              | Madison       | 22-008 | 0.010       |

TABLE 4-1 ABANDONED HARDROCK MINES PRIORITY SITES AIMSS RANKING

## **5.0 SITE SUMMARY FORMS**





**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |   |
|--|---|
| Mine/Site Name: <u>Garrett Hill</u>  | County: <u>Beaverhead</u>                       |
| Legal Description: <u>T 6S R 12W</u>   | Section(s): <u>NE 1/4, NE 1/4, Sec. 15</u>      |
| Mining District: <u>Bald Mountain</u>  | Mine Type: <u>Hardrock/Tungsten</u>             |
| Latitude: <u>N 45° 19' 00"</u>   | Primary Drainage: <u>Dyce Creek</u>             |
| Longitude: <u>W 113° 03' 00"</u>   | USGS Code: <u>10020002</u>                      |
| Land Status: <u>Private</u>  | Secondary Drainage: <u>West Fork Dyce Creek</u> |
| Quad: <u>Polaris</u>   | Date Investigated: <u>September 15, 1993</u>    |
| Inspectors: <u>Bullock/Pierson</u>   | P.A. # <u>01-092</u>                            |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |   |

- The volume of tailings associated with this site was estimated to be 290 cubic yards. The only element determined to be elevated at least three times background was copper measured at 456 mg/kg. The tailings impoundment was in excellent condition with berms intact and most of the surface area is vegetated.
- The volume of waste rock associated with this site was estimated to be 500 cubic yards. The only element elevated at least three times background was copper measured at 325 mg/kg.
- There were no adit discharges, seeps or springs associated with this site.
- No direct pathways to surface water were identified during this investigation.
- The mill building was classified as a hazardous structure.
- There were three trenches, one of which has vertical walls, but was only 3 to 4 feet deep.

**Garrett Hill PA# 01-092**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 09/16/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 01-092-TP-1 | 17.2          | 11.7          | 0.7 U         | 2.85          | 23.7          | 456           | 31800         | 0.028 U       | 556 J         | 6.73          | 4.92 U        | 4.74 UJ       | 21            | NR                 |
| 01-092-WR-1 | 15.1          | 25.6          | 0.9 U         | 4.1           | 2.97          | 325           | 10500         | 0.026 U       | 450 J         | 6.8           | 6.27 U        | 6.05 UJ       | 52.5          | NR                 |
| BACKGROUND  | 76            | 134           | 0.5 U         | 3             | 10            | 14.1          | 12100         | 0.024 J       | 482           | 10            | 23            | 7 J           | 59            | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID       | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|----------------|-------------------|--------------------------------------|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 01-092-TP-1    | <0.01             | 0                                    | 107                           | 107                                       | <0.01                  | <0.01                  | 0.01                   | 0   | 107                                       |
| 01-092-TP-1DUP | <0.01             | 0                                    | 108                           | 108                                       | <0.01                  | <0.01                  | 0.01                   | 0   | 108                                       |
| 01-092-WR-1    | <0.01             | 0                                    | 251                           | 251                                       | <0.01                  | <0.01                  | <0.01                  | 0   | 251                                       |

**LEGEND**

TP1 - Composite of subsamples TP1A and 1B.  
WR1 - Composite of subsamples WR1A through 1D.  
BACKGROUND - From the Ermont Mill (01-005-SS-1).  
TP1DUP - Duplicate of the 01-092-TP-1 sample.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |   |
|--|---|
| Mine/Site Name: <u>Apex Millsite</u>   | County: <u>Beaverhead</u>                         |
| Legal Description: T <u>8S</u> R <u>11W</u>  | Section(s): <u>SW 1/4, SE 1/4, NW 1/4, Sec. 6</u> |
| Mining District: <u>Bannack</u>  | Mine Type: <u>Millsite/Au, Ag, Cu, Pb</u>         |
| Latitude: <u>N 45° 09' 48"</u>   | Primary Drainage: <u>Grasshopper Creek</u>        |
| Longitude: <u>W 112° 59' 50"</u>   | USGS Code: <u>10020002</u>                        |
| Land Status: <u>Public</u>   | Secondary Drainage: <u>Grasshopper Creek</u>      |
| Quad: <u>Bannack</u>   | Date Investigated: <u>September 16, 1993</u>      |
| Inspectors: <u>Bullock/Pierson</u>   | P.A. # <u>01-006</u>                              |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |   |

- The data used to evaluate this site was collected by the MDHES CECRA Program during previous investigations and cleanup efforts.
- The volume of tailings associated with this site was estimated to be approximately 79,800 cubic yards. Previous sampling results have documented elevated levels of arsenic, copper, lead, and zinc in the tailings. A CECRA response action consisting of tailings consolidation and runoff control was conducted by MDHES in 1989. The tailings impoundments were inspected during the MDSL site investigation and were in fair condition. The tailings impoundments were considered to be on the edge of the 100 year flood plain of Grasshopper Creek.
- Monitoring well data did not document any exceedances of MCLs, and no observed releases to groundwater were documented; although, arsenic concentrations were slightly elevated.
- Grasshopper Creek was located approximately 800 feet north (downgradient) of the tailings impoundments. Previous sampling results did not document any observed releases to the Creek attributable to this site.
- One potentially hazardous open adit was identified at the site; although, the adit was gated and locked. The mill building was stabilized as part of the cleanup efforts by MDHES and MDSL/AMRB and is maintained by MDFWP.





**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |  |
|--|--|
| Mine/Site Name: <u>Gold Leaf/Priscilla</u>       | County: <u>Beaverhead</u>                      |
| Legal Description: <u>T 8S R 11W</u>             | Section(s): <u>NW 1/4, Sec. 8</u>              |
| Mining District: <u>Bannack</u>                  | Mine Type: <u>Hardrock/Au, Ag, Pb, Zn, Cu;</u> |
| Latitude: <u>N 45° 09' 19"</u>                   | <u>Placer/Au</u>                               |
| Longitude: <u>W 112° 59' 05"</u>                 | Primary Drainage: <u>Grasshopper Creek</u>     |
| Land Status: <u>Private</u>                      | USGS Code: <u>10020002</u>                     |
| Quad: <u>Bannack</u>                             | Secondary Drainage: <u>Grasshopper Creek</u>   |
| Inspectors: <u>Bullock/Pierson</u>               | Date Investigated: <u>September 16, 1993</u>   |
| Organization: <u>Pioneer Technical Services,</u> | P.A. # <u>01-031</u>                           |
| <u>Inc./Thomas, Dean and Hoskins, Inc.</u>       |  |

- There were approximately 89,000 cubic yards of tailings in two separate impoundments, the Gold Leaf tailings (70,000) and the Excelsior tailings (19,000). The following elements were at least three times background in the Gold Leaf tailings:

|                                  |                               |
|----------------------------------|-------------------------------|
| Arsenic: 429J to 593J mg/kg      | Cadmium: 4.3J to 4.4J mg/kg   |
| Cobalt: 19.4 to 22.7 mg/kg       | Copper: 789 to 902 mg/kg      |
| Iron: 94,000JX to 98,100JX mg/kg | Mercury: 4.09J to 4.59J mg/kg |
| Lead: 589 to 937 mg/kg           | Antimony: 30J to 36.9J mg/kg  |
| Zinc: 587J to 629J mg/kg         |                               |

The following elements were at least three times background in the Excelsior tailings:

|                     |                      |
|---------------------|----------------------|
| Cadmium: 2.6J mg/kg | Cobalt: 42.5 mg/kg   |
| Copper: 925 mg/kg   | Mercury: 11.4J mg/kg |
| Lead: 360 mg/kg     | Zinc: 345J mg/kg     |

- There were no adit discharges, seeps or springs associated with this site.
- Grasshopper creek flowed from west to east through this site. Observed releases were documented for copper and zinc. There were no MCLs or MCLGs exceeded. The acute and chronic aquatic life criteria for zinc were exceeded and could be attributed to this site.
- Other potentially hazardous materials on site included two 55-gallon barrels of lube oil, one 55-gallon barrel of hydraulic oil, one 55-gallon barrel of waste oil, and one sealed 55-gallon barrel of unknown content.
- One HMO, the Priscilla Adit, was open and accessible.

**Gold Leaf/ Priscilla PA# 01-031**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 09/16/93**

| SOLID MATRIX ANALYSES |            |                              |            |            |            |            |            |            |            |            |            |            |            |                 |
|-----------------------|------------|------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| Metals in soils       |            | Results per dry weight basis |            |            |            |            |            |            |            |            |            |            |            |                 |
| FIELD ID              | As (mg/Kg) | Ba (mg/Kg)                   | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 01-031-SE-1           | 9.41 J     | 178 J                        | 1.4 U      | 5.99       | 5.81 J     | 19.9       | 8660 JX    | 0.16 J     | 723        | 12.2       | 12         | 9.47 UJ    | 56.4 J     | NR              |
| 01-031-SE-2           | 18.3 J     | 108 J                        | 0.9 U      | 3.89       | 1.64 J     | 3.13       | 5420 JX    | 0.032 U    | 400        | 5.46       | 6.39 UJ    | 6.17 UJ    | 28.5 J     | NR              |
| 01-031-TP-1           | 593 J      | 198 J                        | 4.4 J      | 22.7       | 12.7 J     | 789        | 94000 JX   | 4.09 J     | 937        | 17.5       | 589        | 36.9 J     | 629 J      | 2.51            |
| 01-031-TP-2           | 429 J      | 118 J                        | 4.3 J      | 19.4       | 11.1 J     | 902        | 98100 JX   | 4.59 J     | 573        | 10.6       | 988        | 30 J       | 587 J      | 3.54            |
| 01-031-TP-3           | 198 J      | 217 J                        | 2.6 J      | 42.5       | 8.03 J     | 925        | 34800 JX   | 11.4 J     | 1360       | 17.3       | 360        | 20.1 J     | 345 J      | 0.142 U         |
| 01-031-WR-1           | 72.8 J     | 60.4 J                       | 1.3 J      | 16.1       | 4.52 J     | 392        | 49000 JX   | 0.547 J    | 454        | 10.6       | 12.1       | 4.86 UJ    | 91.1 J     | NR              |
| 01-031-WR-2           | 116 J      | 55.8 J                       | 1.1 J      | 12.3       | 7.97 J     | 483        | 49700 JX   | 0.788 J    | 536        | 18.6       | 38.7       | 9.41 J     | 93.8 J     | NR              |
| BACKGROUND            | 76         | 134                          | 0.5 U      | 3          | 10         | 14.1       | 12100      | 0.024 J    | 482        | 10         | 23         | 7 J        | 59         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

| Acid/Base Accounting |                |                                |                          |                                  |                  |                  |                  |                                  |                                  |
|----------------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| FIELD ID             | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
| 01-031-TP-1          | 0.25           | 7.81                           | 73.8                     | 66                               | 0.22             | <0.01            | 0.03             | 0                                | 73.8                             |
| 01-031-TP-2          | 0.34           | 10.6                           | 74.3                     | 63.7                             | 0.26             | 0.02             | 0.06             | 0.62                             | 73.7                             |
| 01-031-TP-3          | 0.26           | 8.12                           | 137                      | 129                              | 0.19             | 0.05             | 0.02             | 1.56                             | 135                              |
| 01-031-WR-1          | 3.53           | 110                            | 176                      | 66.1                             | <0.01            | 2.46             | 2.39             | 76.9                             | 99.5                             |
| 01-031-WR-2          | 1.48           | 46.2                           | 115                      | 68.4                             | 0.67             | 0.36             | 0.45             | 11.2                             | 103                              |

| WATER MATRIX ANALYSES |      |                 |        |     |        |        |     |        |      |        |      |        |        |                                |
|-----------------------|------|-----------------|--------|-----|--------|--------|-----|--------|------|--------|------|--------|--------|--------------------------------|
| Metals in Water       |      | Results in ug/L |        |     |        |        |     |        |      |        |      |        |        | HARDNESS CALC. Zn (mg CaCO3/L) |
| FIELD ID              | As   | Ba              | Cd     | Co  | Cr     | Cu     | Fe  | Hg     | Mn   | Ni     | Pb   | Sb     |        |                                |
| 01-031-SW-1           | 2.62 | 51              | 4.59 U | 5 U | 6.24 U | 7.3    | 228 | 0.12 U | 22.3 | 74.4   | 1.14 | 31.7 U | 248    | 84                             |
| 01-031-SW-2           | 1.73 | 50.5            | 4.59 U | 5 U | 6.24 U | 2.33 U | 215 | 0.12 U | 15.6 | 10.9 U | 1.3  | 31.7 U | 8.71 U | 82.9                           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

| Wet Chemistry Results in mg/l |                        |          |         |           |         |
|-------------------------------|------------------------|----------|---------|-----------|---------|
| FIELD I.D.                    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
| 01-031-SW-1                   | 141                    | 6        | 16      | < 0.05    | NR      |
| 01-031-SW-2                   | 182                    | 6        | 17      | 0.05      | NR      |

**LEGEND**

SE1 - Downgradient of tailing pond 2 on Grasshopper Creek.  
 SE2 - Upgradient of waste rock dump 4 on Grasshopper Creek.  
 TP1 - Composite of subsamples TP1A, 1B-A, and 1B-B.  
 TP2 - Composite of subsamples TP1C-A, 1C-B, and 1C-C.  
 TP3 - Composite of subsamples TP2A and 2B.  
 WR1 - Composite of subsamples WR1A, 1B, 2A, and 2B.  
 WR2 - Composite of subsamples WR4A, 4B, 4C, 5A, 5B, and 5C.  
 BACKGROUND - From the Ermont Mill (01-005-SS-1).

SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Indian Queen</u>   | County: <u>Beaverhead</u>                  |
| Legal Description: <u>T 5S R 10W</u>  | Section(s): <u>NE 1/4, SE 1/4, Sec. 15</u> |
| Mining District: <u>Birch Creek</u>   | Mine Type: <u>Hardrock/Cu</u>              |
| Latitude: <u>N 45 ° 53' 55"</u>   | Primary Drainage: <u>Birch Creek</u>       |
| Longitude: <u>W 112 ° 49' 10"</u>   | USGS Code: <u>10020004</u>                 |
| Land Status: <u>Private</u>   | Secondary Drainage: <u>Birch Creek</u>     |
| Quad: <u>Twin Adams Mountain</u>  | Date Investigated: <u>June 15, 1993</u>    |
| Inspectors: <u>Babits, Lasher, Belanger, Clark/<br/>Pierson</u>                           | P.A. # <u>01-034</u>                       |
| Organization: <u>Pioneer Technical Services,<br/>Inc./Thomas, Dean, and Hoskins, Inc.</u> |  |

- There were no mill tailings at this site.
- There were approximately 2,600 cubic yards of mostly uncovered slag at the site that extend to the creek. The following were elevated at least three times background:

|                         |                     |
|-------------------------|---------------------|
| Cobalt: 57.3 mg/kg      | Chromium: 40 mg/kg  |
| Copper: 7,130 mg/kg     | Iron: 155,000 mg/kg |
| Manganese: 14,300 mg/kg | Nickel: 19 mg/kg    |
| Zinc: 873 mg/kg         |                     |
- There was approximately 15,490 cubic yards of uncovered waste rock. The following were elevated at least three times background:

|                               |                                 |
|-------------------------------|---------------------------------|
| Arsenic: 377 to 5,210 mg/kg   | Cadmium: 7.4 to 15.6 mg/kg      |
| Cobalt: 20.2 to 74.6 mg/kg    | Chromium: 16.4 to 48.2 mg/kg    |
| Copper: 2,070 to 15,900 mg/kg | Iron: 88,400 to 107,000 mg/kg   |
| Mercury: 0.715 to 0.822 mg/kg | Manganese: 1,800 to 2,910 mg/kg |
| Nickel: 10 to 25 mg/kg        | Lead: 468 to 503 mg/kg          |
| Zinc: 431 to 1,490 mg/kg      |                                 |
- There were no discharging adits identified at the site.
- No surface water samples were collected from Birch Creek due to extremely high water conditions; however, observed releases to Birch Creek sediment were documented for arsenic, cadmium, cobalt, copper, manganese, nickel, lead, and zinc.

**Indian Queen PA# 01-034**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER-BABITS**  
**INVESTIGATION DATE: 06/15/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 01-034-SE-1 | 5             | 38.9          | < 0.7         | 2.6           | 5.7           | 14            | 28400         | < 0.019       | 237           | < 3           | 9             | < 5           | 29            | NR                 |
| 01-034-SE-2 | 448           | 91.8          | 7.9           | 15.4          | 11.1          | 4200          | 51900         | < 0.029       | 1100          | 9             | 176           | < 6           | 432           | NR                 |
| 01-034-SG-1 | 105           | 42.6          | 4.6           | 57.3          | 40            | 7130          | 155000        | < 0.013       | 14300         | 19            | 47            | < 3           | 873           | NR                 |
| 01-034-WR-1 | 759           | 9.1           | 7.4           | 20.2          | 17.1          | 15900         | 107000        | 0.169         | 2910          | 10            | 503           | < 4           | 431           | NR                 |
| 01-034-WR-2 | 377           | 253           | 15.6          | 9.7           | 8.1           | 826           | 28000         | 0.822         | 1800          | 12            | 20            | < 9           | 646           | NR                 |
| 01-034-WR-3 | 5210          | 79.1          | 11.5          | 74.6          | 48.2          | 13500         | 92100         | 0.215         | 1820          | 25            | 468           | 11            | 1490          | NR                 |
| 01-034-WR-4 | 1150          | 55.1          | 1.3           | 12.3          | 16.4          | 2070          | 88400         | 0.715         | 2320          | 7             | 96            | < 3           | 244           | NR                 |
| BACKGROUND  | 43            | 104           | 2.2           | 6.5           | 5.1           | 382           | 19200         | 0.085         | 582           | 3             | 56            | < 4           | 117           | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid Base/Accounting

| FIELD ID       | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | TOTAL<br>SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | PYRITIC<br>SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|----------------|-------------------|--------------------------------------|-------------------------------|--|------------------------|------------------------|------------------------|---|--|
| 01-034-WR-1    | 0.47              | 14.7                                 | 15.2                          | 0.49   | 0.02                   | <0.01                  | 0.49                   | 0   | 15.2   |
| 01-034-WR1-DUP | 0.48              | 15                                   | 15.9                          | 0.95   | <0.01                  | <0.01                  | 0.51                   | 0   | 15.9   |
| 01-034-WR-2    | 0.02              | 0.62                                 | 41                            | 40.3   | 0.02                   | <0.01                  | <0.01                  | 0   | 41   |
| 01-034-WR-3    | 0.06              | 1.87                                 | 49.3                          | 47.4   | 0.05                   | <0.01                  | 0.01                   | 0   | 49.3   |
| 01-034-WR-4    | 0.02              | 0.62                                 | 37.2                          | 36.5   | 0.02                   | <0.01                  | <0.01                  | 0   | 37.2   |

**LEGEND**

SE1 - 20' upgradient of slag on Birch Creek.  
SE2 - 20' downgradient of slag on Birch Creek.  
SG1 - slag from East on road on creek.  
WR1 - Sample of subsample WR1B.  
WR2 - Composite of subsamples WR1A, 1B, and 1C.  
WR3 - Composite of subsamples WR3A and 5.  
WR4 - Composite of subsamples WR2, 3B, and 4.  
WR1-DUP - Duplicate of 01-034-WR-1.  
BACKGROUND - From Indian Queen (01-0340SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |   |
|--|---|
| Mine/Site Name: <u>Old Elkhorn</u>   | County: <u>Beaverhead</u>                     |
| Legal Description: <u>T 4S R 12W</u>   | Section(s): <u>NE 1/4, NE 1/4, Sec. 14</u>    |
| Mining District: <u>Elkhorn</u>  | Mine Type: <u>Hardrock/Au, Ag, Cu, Pb, Zn</u> |
| Latitude: <u>N 45° 29' 23"</u>   | Primary Drainage: <u>Wise River</u>           |
| Longitude: <u>W 113° 02' 18"</u>   | USGS Code: <u>10020004</u>                    |
| Land Status: <u>Public</u>   | Secondary Drainage: <u>Elkhorn Creek</u>      |
| Quad: <u>Elkhorn Hot Springs</u>   | Date Investigated: <u>September 15, 1993</u>  |
| Inspectors: <u>Bullock/Pierson</u>   | P.A. # <u>01-169</u>                          |
| Organization: <u>Pioneer Technical Services,<br/>Inc./Thomas, Dean and Hoskins, Inc.</u> |   |

- Ore from this site was milled at the Elkhorn Mill, PA# 01-009.
- The volume of waste rock associated with this site was estimated to be 50,000 cubic yards. The following elements were elevated at least three times background:

|                                |                                     |
|--------------------------------|-------------------------------------|
| Arsenic: 121J mg/kg            | Mercury: 1.59J mg/kg to 1.75J mg/kg |
| Cadmium: 4.8J mg/kg            | Lead: 717 mg/kg                     |
| Copper: 189 mg/kg to 573 mg/kg | Zinc: 821J mg/kg                    |
- There was one open adit identified with a discharge associated with this site with a significant estimated flow of 150 gpm. The pH at this discharge point was 5.72 and the specific conductance was measured at 291 umhos/cm. The MCL for cadmium was exceeded in the adit discharge. Acute and chronic aquatic life criteria were exceeded for iron, cadmium, copper, lead, and zinc were exceeded. A portion of the adit discharge flows over and through waste rock to a settling pond prior to discharging into Elkhorn Creek. There are two seeps associated with this site. The PPE for the adit discharge was sampled as SW-3 just prior to its confluence with Elkhorn Creek. One seep emanates from the northern toe of a waste rock dump characterized by sample SW-2. The MCL/MCLGs were exceeded for cadmium (SW-2, SW-3) and copper (SW-2). The MCL/MCLG for antimony was exceeded for the seep (SW-2). Acute aquatic life criteria was exceeded for copper and zinc in SW-2 and SW-3. Chronic aquatic life criteria were exceeded for cadmium, copper, lead, and zinc in SW-2 and SW-3.
- Two surface water samples were collected on Elkhorn Creek; SW-1 was downstream and SW-4 was upstream of the site. Observed releases to Elkhorn Creek were documented for copper and zinc. No MCLs were exceeded; however, acute and chronic aquatic life criteria were exceeded for copper and zinc which were directly attributable to the site.
- There were two potentially hazardous structures associated with this property. In addition, WR-1 was rated overly steep and was eroding. The open adit was classified as a hazardous mine opening, especially due to the heavy tourist use.



**Old Elkhorn PA# 01-169**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 09/16/93**

| SOLID MATRIX ANALYSES   |                |                                |                          |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
|---|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|------------|------------|------------|------------|-----------------|
| Metals in soils   |                | Results per dry weight basis   |                          |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
| FIELD ID  | As (mg/Kg)     | Ba (mg/Kg)                     | Cd (mg/Kg)               | Co (mg/Kg)                       | Cr (mg/Kg)       | Cu (mg/Kg)       | Fe (mg/Kg)       | Hg (mg/Kg)                       | Mn (mg/Kg)                       | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 01-169-SE-1   | 7.09 J         | 35.4 J                         | 0.9 U                    | 2.37                             | 1.22 U           | 52.9             | 6980 JX          | 0.032 U                          | 392                              | 4.58       | 6.68       | 6.18 UJ    | 134 J      | NR              |
| 01-169-SE-2   | 4.02 U         | 18.2 J                         | 0.8 U                    | 1.09                             | 1.05 U           | 1.83             | 2820 JX          | 0.031 U                          | 251                              | 4          | 5.51 UJ    | 5.32 UJ    | 19 J       | NR              |
| 01-169-WR-1   | 17.1 J         | 121 J                          | 0.9 U                    | 4.59                             | 1.18 U           | 189              | 14500 JX         | 1.59 J                           | 393                              | 5.16       | 22.2       | 5.99 UJ    | 123 J      | NR              |
| 01-169-WR-2   | 121 J          | 55.1 J                         | 4.8 J                    | 4.19                             | 1.25 U           | 573              | 18200 JX         | 1.75 J                           | 1590                             | 4.13       | 717        | 9.92 J     | 821 J      | NR              |
| BACKGROUND  | 12.3 J         | 182 J                          | 1.1 U                    | 6.54                             | 4.37 J           | 17.8             | 12300 JX         | 0.052 J                          | 1170                             | 8.28       | 15.8       | 7.35 UJ    | 158 J      | NR              |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                |                                |                          |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
| Acid/Base Accounting  |                |                                |                          |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
| FIELD ID  | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |            |            |            |            |                 |
| 01-169-WR-1   | 0.26           | 8.12                           | 33.1                     | 25                               | <0.01            | 0.09             | 0.17             | 2.81                             | 30.3                             |            |            |            |            |                 |
| 01-169-WR-2   | 1.07           | 33.4                           | 7.61                     | -26                              | 0.38             | 0.11             | 0.58             | 3.44                             | 4.18                             |            |            |            |            |                 |

| WATER MATRIX ANALYSES   |        |                 |        |      |        |        |      |        |      |        |        |        |                 |                |  |
|---|--------|-----------------|--------|------|--------|--------|------|--------|------|--------|--------|--------|-----------------|----------------|--|
| Metals in Water   |        | Results in ug/L |        |      |        |        |      |        |      |        |        |        |                 | HARDNESS CALC. |  |
| FIELD ID  | As     | Ba              | Cd     | Co   | Cr     | Cu     | Fe   | Hg     | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) |                |  |
| 01-169-GW-1   | 19.9   | 5.03            | 17.8   | 6.47 | 6.24 U | 745    | 3590 | 0.12 U | 3590 | 10.9 U | 107    | 31.7 U | 3630            | 99.3           |  |
| 01-169-SW-1   | 1.12 U | 11.7            | 4.59 U | 5 U  | 6.24 U | 23.6   | 32.2 | 0.12 U | 71.1 | 10.9 U | 1.88   | 31.7 U | 159             | 22.8           |  |
| 01-169-SW-2   | 1.18   | 8.2             | 49.2   | 10   | 6.24 U | 2930   | 926  | 0.12 U | 9490 | 14.7   | 57.5   | 50.8   | 11100           | 225            |  |
| 01-169-SW-3   | 1.26   | 11.8            | 16.5   | 6.33 | 6.24 U | 700    | 193  | 0.12 U | 3210 | 10.9 U | 25     | 31.7 U | 3500            | 102            |  |
| 01-169-SW-4   | 1.12 U | 10.1            | 4.59 U | 5 U  | 6.24 U | 2.33 U | 30.1 | 0.12 U | 7.47 | 10.9 U | 0.94 U | 35.3   | 8.71 U          | 17.3           |  |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |        |                 |        |      |        |        |      |        |      |        |        |        |                 |                |  |

| Wet Chemistry |                        | Results in mg/l |         |           |         |  |
|---------------|------------------------|-----------------|---------|-----------|---------|--|
| FIELD ID.     | TOTAL DISSOLVED SOLIDS | CHLORIDE        | SULFATE | NO3/NO2-N | CYANIDE |  |
| 01-169-GW-1   | 238                    | < 5             | 124     | 0.09      | NR      |  |
| 01-169-SW-1   | 67                     | < 5             | 12      | 0.07      | NR      |  |
| 01-169-SW-2   | 542                    | < 5             | 297     | 0.05      | NR      |  |
| 01-169-SW-3   | 204                    | < 5             | 131     | < 0.05    | NR      |  |
| 01-169-SW-4   | 42                     | < 5             | < 5     | 0.05      | NR      |  |

SE1 - Downgradient Elkhorn Creek near old bridge.  
SE2 - Upgradient Elkhorn Creek.  
WR1 - Composite of subsamples WR1A and 1B.  
WR2 - Composite of subsamples WR1C through 1G.  
BACKGROUND - From the Old Elkhorn Mine (01-169-SS-1).

GW1 - Adit #1 discharge.  
SW1 - Same as sample SE1.  
SW2 - Seepage from North end of waste rock dump 1 at PPE to Elkhorn Creek.  
SW3 - Adit discharge at PPE to Elkhorn Creek.  
SW4 - Upgradient Elkhorn Creek.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |  |
|--|--|
| Mine/Site Name: <u>Ermont Mill</u>               | County: <u>Beaverhead</u>                  |
| Legal Description: <u>T 6S R 11W</u>             | Section(s): <u>NW 1/4, SE 1/4, Sec. 35</u> |
| Mining District: <u>Ermont</u>                   | Mine Type: <u>Hardrock/Ag, Au, Cu</u>      |
| Latitude: <u>N 45° 16' 05"</u>                   | Primary Drainage: <u>Beaverhead River</u>  |
| Longitude: <u>W 112° 54' 50"</u>                 | USGS Code: <u>10020002</u>                 |
| Land Status: <u>Public</u>                       | Secondary Drainage: <u>Ermont Gulch</u>    |
| Quad: <u>Ermont</u>                              | Date Investigated: <u>June 14, 1993</u>    |
| Inspectors: <u>Babits, Belanger, Lasher,</u>     | P.A. # <u>01-005</u>                       |
| <u>Clark/Pierson</u>                             |  |
| Organization: <u>Pioneer Technical Services,</u> |  |
| <u>Inc./Thomas, Dean and Hoskins, Inc.</u>       |  |

- There were approximately 200,000 cubic yards of uncovered tailings on site. The following were elevated at least three times background:

|                      |                      |
|----------------------|----------------------|
| Arsenic: 3,510 mg/kg | Mercury: 1.38J mg/kg |
| Barium: 796 mg/kg    | Antimony: 54J mg/kg  |
| Cobalt: 11.5 mg/kg   | Zinc: 334 mg/kg      |
| Iron: 36,500 mg/kg   |                      |
  
- There were approximately 4,160 cubic yards of uncovered waste rock on site. The following were elevated at least three times background:

|                      |
|----------------------|
| Arsenic: 431 mg/kg   |
| Cobalt: 9.3 mg/kg    |
| Mercury: 1.06J mg/kg |
  
- There were no discharging adits on site.
  
- A dry intermittent drainage was identified on site; however, no surface water or sediment samples were collected because the nearest flowing water was one and one-half miles from the site.

**Ermont Mill and Mines PA# 01-005**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 06/14/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 01-005-TP-1 | 3510          | 796           | 1.3           | 11.5          | 11.8          | 22.4          | 36500         | 1.38 J        | 852           | 14            | 61            | 54 J          | 334           | 13.5               |
| 01-112-WR-1 | 431           | 192           | 0.4 U         | 9.3           | 5.1           | 17.6          | 20300         | 1.06 J        | 629           | 6             | 16            | 10 J          | 43            | NR                 |
| BACKGROUND  | 76            | 134           | 0.5 U         | 3             | 10            | 14.1          | 12100         | 0.024 J       | 482           | 10            | 23            | 7 J           | 59            | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL.<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|----------------------|---|--------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 01-005-TP-1 | 0.14                 | 4.37                                    | 84.2                           | 79.8                                      | 0.13                   | <0.01                  | 0.02                   | 0   | 84.2                                      |
| 01-112-WR-1 | <0.01                | 0                                       | 398                            | 398                                       | <0.01                  | 0.01                   | <0.01                  | 0.31                                      | 398                                       |

**LEGEND**

TP1 - Composite of subsamples TP1A-A, -B, -C, and 1B-A, -B, -C, -D, -E.  
WR1 - Composite of subsamples WR1, 2A, 2B, 3, and 5.  
BACKGROUND - Accross drainage from adit #4.  
From the Ermont Mill (01-005-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Silver King</u>                    | County: <u>Beaverhead</u>                  |
| Legal Description: <u>T 3S R 11W</u>                  | Section(s): <u>NE 1/4, SW 1/4, Sec. 11</u> |
| Mining District: <u>Hecla</u>                         | Mine Type: <u>Hardrock/Pb, Zn, Ag</u>      |
| Latitude: <u>N 45° 35' 08"</u>                        | Primary Drainage: <u>Big Hole River</u>    |
| Longitude: <u>W 112° 55' 42"</u>                      | USGS Code: <u>10020004</u>                 |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Trapper Creek</u>   |
| Quad: <u>Hardrock/Pb, Zn, Ag</u>                      | Date Investigated: <u>August 26, 1993</u>  |
| Inspectors: <u>Bullock, Tuesday</u>                   | P.A. # <u>01-094</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no mill tailings found to be associated with this site.
- The volume of waste rock associated with this site was estimated to be approximately 1,100 cubic yards. The following elements were elevated at least three times background:
  - Cadmium: 918J mg/kg
  - Mercury: 26.6J mg/kg
  - Lead: 32,300JX mg/kg
  - Antimony: 339J mg/kg
  - Zinc: 113,000J mg/kg
- There were two collapsed adits observed at this site. Groundwater was not likely to be present; and limestone was present to buffer water that may pass through the old workings. There were no adit discharges, seeps or springs associated with this site.
- There were no direct pathways observed from this site to Trapper Creek, located approximately ¼ mile below the site. No surface water or groundwater samples were collected.
- No other hazardous materials were observed at this site.



**Silver King PA# 01-094**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/26/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 01-094-WR-1 | 91.9          | 23 J          | 918.00 J      | 2.68          | 4.57 JX       | 266           | 25800         | 26.6 J        | 544 J         | 7.99 JX       | 32300 JX      | 339 J         | 113000 J      | NR                 |
| BACKGROUND  | 43            | 104           | 2.2           | 6.5           | 5.1           | 382           | 19200         | 0.085 J       | 582           | 3             | 56            | 4 UJ          | 117           | < 0.271            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID       | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|----------------|----------------------|---|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 01-094-WR-1    | 0.67                 | 20.9                                    | 401                           | 380                                       | <0.01                  | 0.66                   | 0.3                    | 20.6                                      | 381                                       |
| 01-094-WR-1DUP | 0.67                 | 20.9                                    | 406                           | 385                                       | <0.01                  | 0.7                    | 0.28                   | 21.9                                      | 384                                       |

**LEGEND**

SE2 -  
WR1 - Composite of subsamples WR1A, 1B, and 2.  
BACKGROUND - From the Indian Queen Mine (01-034-SS-1).  
WR1DUP - Duplicate of the 01-094-WR-1 sample.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |   |
|--|---|
| Mine/Site Name: <u>Lower and Upper Cleve</u>   | County: <u>Beaverhead</u>                       |
| Legal Description: <u>T 3S R 11W</u>   | Section(s): <u>NE 1/4, SW 1/4, Sec. 1</u>       |
| Mining District: <u>Hecla</u>  | Mine Type: <u>Hardrock/Ag, Cu, Pb</u>           |
| Latitude: <u>N 45° 36' 14"</u>   | Primary Drainage: <u>Trapper Creek/Big Hole</u> |
| Longitude: <u>W 112° 54' 45"</u>   | <u>River</u>                                    |
| Land Status: <u>Private</u>  | USGS Code: <u>10020004</u>                      |
| Quad: <u>Mount Tahepia</u>   | Secondary Drainage: <u>Sappington Creek</u>     |
| Inspectors: <u>Bullock/Pierson</u>   | Date Investigated: <u>September 14, 1993</u>    |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> | P.A. # <u>01-143</u>                            |

- There were no mill tailings found to be associated with this site.
- The volume of waste rock associated with this site was estimated to be 49,000 cubic yards. (Upper Cleve adits and dumps were added due to the close proximity and contribution to erosion problems.) The following elements were elevated at least three times background:

|                               |                              |
|-------------------------------|------------------------------|
| Arsenic: 268J to 615J mg/kg   | Nickel: 12.8 mg/kg           |
| Cadmium: 18.9 to 51.0 mg/kg   | Lead: 1,920 to 9,770 mg/kg   |
| Copper: 1,540 mg/kg           | Antimony: 225J to 352J mg/kg |
| Mercury: 8.97J to 16.6J mg/kg | Zinc: 3,310 to 7,670 mg/kg   |
| Manganese: 6,600 mg/kg        |                              |
- There were no adit discharges, seeps or springs identified at this site.
- The mine was located near the headwaters of the North Fork of Sappington Creek. Surface water samples were collected upstream and downstream from the site; no MCLs/MCLGs or acute or chronic aquatic life criteria were exceeded. The pH ranged between 8.63 and 8.80 and Eh ranged between 218 to 240 mV.
- Observed releases to the North Fork of Sappington Creek (sediment) were documented for arsenic, lead, and antimony.
- Two open adits located at this site were classified as hazardous mine openings.

**Upper and Lower Cleve PA# 01-143**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 09/14/93**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 01-143-SE-1 | 319 J      | 31.1       | 8.92       | 7.61       | 9.51       | 416        | 24800      | 3.51 J     | 542        | 19.5       | 1680       | 327 J      | 1310       | NR              |
| 01-143-SE-2 | 162 J      | 22.8       | 14.70      | 4.89       | 11.9       | 522        | 12800      | 6.28 J     | 670        | 12.1       | 3930       | 135 J      | 2730       | NR              |
| 01-143-SE-3 | 81.5 J     | 46.6       | 5.43       | 4.41       | 11.3       | 214        | 12500      | 1.88 J     | 704        | 14.7       | 1270       | 51.5 J     | 1230       | NR              |
| 01-143-WR-1 | 615 J      | 22.7       | 51.00      | 3.11       | 5.68       | 1540       | 12700      | 16.6 J     | 6600       | 12.8       | 9770       | 352 J      | 7670       | NR              |
| 01-143-WR-2 | 268 J      | 0.19 U     | 18.90      | 1.09       | 2.14       | 440        | 11500      | 8.97 J     | 878        | 4.36       | 1920       | 225 J      | 3310       | NR              |
| BACKGROUND  | 43         | 104        | 2.2        | 6.5        | 5.1        | 382        | 19200      | 0.085 J    | 582        | 3          | 56         | 4 UJ       | 117        | < 0.271         |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 01-143-WR-1 | <0.01          | 0                              | 482                      | 482                              | <0.01            | <0.01            | 0.01             | 0                                | 482                              |
| 01-143-WR-2 | <0.01          | 0                              | 497                      | 497                              | <0.01            | <0.01            | 0.01             | 0                                | 497                              |

**WATER MATRIX ANALYSES**

**Metals in Water**  
**Results in ug/L**

| FIELD ID    | As   | Ba   | Cd     | Co  | Cr     | Cu     | Fe     | Hg     | Mn     | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|------|--------|-----|--------|--------|--------|--------|--------|--------|------|--------|-----------------|----------------|
| 01-143-SW-1 | 3.09 | 13.1 | 4.59 U | 5 U | 6.24 U | 2.33 U | 13.7 U | 0.23 J | 3.76 U | 10.9 U | 2.58 | 31.7 U | 15.6            | 159            |
| 01-143-SW-2 | 2.81 | 11.5 | 4.59 U | 5 U | 6.24 U | 2.33 U | 15.5   | 0.13 J | 3.76 U | 10.9 U | 1.33 | 31.7 U | 8.71 U          | 154            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Wet Chemistry**  
**Results in mg/l**

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 01-143-SW-1 | 193                    | < 5      | < 5     | 0.1       | NR      |
| 01-143-SW-2 | 199                    | < 5      | 5       | 0.1       | NR      |

**LEGEND**

SE1 - Downgradient sediment; 650' below road to Trapper Mine in Sappington Creek.  
 SE2 - 150' below waste rock dump 1 on Sappington Creek.  
 SE3 - 110' above waste rock dump 1 on Sappington Creek.  
 WR1 - Composite of subsamples WR1A and 1C.  
 WR2 - Composite of subsamples WR2A and 2B.  
 BACKGROUND - From the Indian Queen Mine (01-034-SS-1).

SW1 - 150' below waste rock dump 1 on Sappington Creek.  
 SW2 - 110' above waste rock dump 1 on Sappington Creek.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Trapper</u>                        | County: <u>Beaverhead</u>                        |
| Legal Description: <u>T 3S R 11W</u>                  | Section(s): <u>NW 1/4, NW 1/4, Sec. 12</u>       |
| Mining District: <u>Hecla</u>                         | Mine Type: <u>Hardrock/Au, Ag, Pb, Cu</u>        |
| Latitude: <u>N 45° 35' 45"</u>                        | Primary Drainage: <u>Trapper Creek</u>           |
| Longitude: <u>W 112° 54' 52"</u>                      | USGS Code: <u>10020004</u>                       |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>N. Fk. Sappington Ck.</u> |
| Quad: <u>Mount Tahepia</u>                            | Date Investigated: <u>August 26, 1993</u>        |
| Inspectors: <u>Bullock, Tuesday</u>                   | P.A. # <u>01-144</u>                             |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- The volume of mill tailings associated with this site was estimated to be 1,460 cubic yards. The following elements were elevated at least three times background:

|                               |                              |
|-------------------------------|------------------------------|
| Arsenic: 818J to 1,260J mg/kg | Manganese: 1770 mg/kg        |
| Cadmium: 65.9J to 110J mg/kg  | Nickel: 16.3 to 34.3 mg/kg   |
| Chromium: 16.8 mg/kg          | Lead: 7860 to 13,600 mg/kg   |
| Copper: 2570 to 3980 mg/kg    | Antimony: 463 to 536 mg/kg   |
| Mercury: 39.6J to 85.8J mg/kg | Zinc: 21,800 to 24,200 mg/kg |
- The volume of waste rock associated with this site was estimated to be 6,700 cubic yards. The following elements were elevated at least three times background:

|                      |                     |
|----------------------|---------------------|
| Arsenic: 505J mg/kg  | Nickel: 10.6 mg/kg  |
| Cadmium: 96.2J mg/kg | Antimony: 157 mg/kg |
| Mercury: 10.6J mg/kg | Zinc: 1060 mg/kg    |
- There were no adit discharges, seeps or springs observed at this site.
- The Main Fork of Sappington Creek appeared to flow through and around the tailings pond during high flow events. Surface water samples were collected up and down stream of this site and there were no documented releases or MCL/MCLGs exceedences. No acute or chronic aquatic life criteria were exceeded. Sediment samples were collected up and down stream from this site. Observed releases of copper, lead, mercury, nickel, and zinc were documented in the sediments.
- There were two hazardous structures identified at this site, the old mill and a cabin.



**Trapper PA# 01-144**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 09/15/93**

| SOLID MATRIX ANALYSES |            |                              |            |            |            |            |            |            |            |            |            |            |            |                 |
|-----------------------|------------|------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| Metals in soils       |            | Results per dry weight basis |            |            |            |            |            |            |            |            |            |            |            |                 |
| FIELD ID              | As (mg/Kg) | Ba (mg/Kg)                   | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 01-144-SE-1           | 11.1       | 13.4 J                       | 0.987 UJ   | 3.48       | 8.27 JX    | 22.1       | 7640       | 0.181 J    | 302 J      | 9.57 JX    | 374 JX     | 10.9 J     | 206 J      | NR              |
| 01-144-SE-2           | 5.62       | 12.4 J                       | 0.953 UJ   | 2.37       | 3.14 JX    | 0.484 U    | 3920       | 0.038 UJ   | 251 J      | 2.55 JX    | 6.81 UJX   | 6.58 UJ    | 22.7 J     | NR              |
| 01-144-TP-1           | 818 J      | 4.92                         | 65.9 J     | 2.78       | 6.58       | 2570       | 10200      | 39.6 J     | 811        | 16.3       | 7860       | 463        | 21800      | NR              |
| 01-144-TP-2           | 1260 J     | 32.5                         | 110 J      | 6.71       | 16.8       | 3980       | 18500      | 85.8 J     | 1770       | 34.3       | 13600      | 536        | 24200      | NR              |
| 01-144-WR-1           | 505 J      | 0.187 U                      | 96.2 J     | 2.46       | 1.48       | 0.396 U    | 7240       | 34.3 J     | 1180       | 10.6       | 5.58 U     | 157        | 1060       | NR              |
| BACKGROUND            | 43         | 104                          | 2.2        | 6.5        | 5.1        | 382        | 19200      | 0.085 J    | 582        | 3          | 56         | 4 UJ       | 117        | < 0.271         |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 01-144-TP-1 | 0              | 1                              | 188                      | 187                              | 0                | <0.01            | <0.01            | 0                                | 188                              |
| 01-144-TP-2 | 0              | 1                              | 136                      | 135                              | <0.01            | 0                | 0                | 1                                | 135                              |
| 01-144-WR-1 | 0              | 2                              | 888                      | 886                              | 0                | <0.01            | 0                | 0                                | 888                              |

| WATER MATRIX ANALYSES |        |                 |        |     |        |        |        |      |        |        |        |        |                 |                |
|-----------------------|--------|-----------------|--------|-----|--------|--------|--------|------|--------|--------|--------|--------|-----------------|----------------|
| Metals in Water       |        | Results in ug/L |        |     |        |        |        |      |        |        |        |        |                 |                |
| FIELD ID              | As     | Ba              | Cd     | Co  | Cr     | Cu     | Fe     | Hg   | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
| 01-144-SW-1           | 1.12 U | 32.8            | 4.59 U | 5 U | 6.24 U | 2.33 U | 31.1 J | 0.22 | 3.76 U | 10.9 U | 1.02   | 31.7 U | 11.4            | 152            |
| 01-144-SW-2           | 1.12 U | 31.1            | 4.59 U | 5 U | 6.24 U | 2.33 U | 36.3 J | 0.2  | 5.8    | 10.9 U | 0.94 U | 31.7 U | 8.71 U          | 168            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Wet Chemistry**

**Results in mg/l**

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 01-144-SW-1 | 179                    | < 5.0    | 6       | < 0.05    | NR      |
| 01-144-SW-2 | 169                    | < 5.0    | < 5     | < 0.05    | NR      |

**LEGEND**

SE1 - Sappington Creek 200 feet below last tailings pond.  
 SE2 - Sappington Creek 100 feet upstream from waste rock.  
 TP1 - Composite of subsamples TP1B, 2AA, and 3AA.  
 TP2 - Composite of subsamples TP2AB and 3AB.  
 WR1 - Composite of subsamples WR1A, 1B, 2A, and 2B.  
 BACKGROUND - From Indian Queen Mine (01-034-SS-1).

SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>South Frying Pan Creek</u>         | County: <u>Beaverhead</u>                         |
| Legal Description: <u>T 10S R 15W</u>                 | Section(s): <u>NE 1/4, NW 1/4, Sec. 28</u>        |
| Mining District: <u>Lemhi Pass</u>                    | Mine Type: <u>Hardrock/Unknown</u>                |
| Latitude: <u>N 45° 56' 15"</u>                        | Primary Drainage: <u>Frying Pan Creek</u>         |
| Longitude: <u>W 113° 26' 56"</u>                      | USGS Code: <u>10020001</u>                        |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>South Frying Pan Creek</u> |
| Quad: <u>Lemhi Pass</u>                               | Date Investigated: <u>August 25, 1993</u>         |
| Inspectors: <u>Bullock, Tuesday</u>                   | P.A. # <u>01-211</u>                              |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- This site was an uranium mine associated with the Last Chance No. 1 (PA# 01-216) and the Last Chance No. 2 (PA# 01-220)
- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 400 cubic yards. The following elements were elevated at least three times background:

|                              |                                 |
|------------------------------|---------------------------------|
| Arsenic: 89.3 mg/kg          | Copper: 43.3 to 442 mg/kg       |
| Barium: 4,520J mg/kg         | Mercury: 0.156J to 0.565J mg/kg |
| Cobalt: 26.2 mg/kg           | Manganese: 6,620 mg/kg          |
| Chromium: 16.1 mg/kg         | Lead: 90.7 to 1,120 mg/kg       |
| Antimony: 28.5J mg/kg        | Zinc: 420 mg/kg                 |
| Thorium-238: 27 to 530 pCi/l | Thorium-230: 140 pCi/l          |
- No discharging adits, filled shafts, seeps, or springs were observed at the site during the investigation.
- South Frying Pan Creek was flowing directly south of the site. Surface water and sediment samples were collected upstream and downstream from the site in the creek. An observed release to South Frying Pan Creek (sediment) was documented for barium, which was directly attributable to the site. No MCL/MCLGs or aquatic life criteria attributable to this site were exceeded; however, the chronic aquatic life criteria for lead was exceeded in both the upstream and downstream samples.
- Relatively high radiation readings (0.60 mR/HR) were observed in a portion of the waste rock material at this site.
- The waste rock dump was very steep and unstable and posed a potential safety hazard.

**South Frying Pan Creek PA# 01-211**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/25/93**

**SOLID MATRIX ANALYSES**

| Metals in soils |            | Results per dry weight basis |            |            |            |            |            |            |            |            |            |            |            |                 |  |
|-----------------|------------|------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|--|
| FIELD ID        | As (mg/Kg) | Ba (mg/Kg)                   | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |  |
| 01-211-SE-1     | 9.79 U     | 234 J                        | 1.9 U      | 3.15       | 7.94       | 7.45       | 5530       | 0.057 U    | 84         | 13.6 J     | 13.4 U     | 12.9 UJ    | 25.4       | NR              |  |
| 01-211-SE-2     | 7.01 U     | 63.8 J                       | 1.3 U      | 2.65       | 6.83       | 2.56       | 5310       | 0.04 U     | 141        | 8.13 J     | 9.61 U     | 10.3 J     | 15.5       | NR              |  |
| 01-211-WR-1     | 89.3       | 4520 J                       | 2.5        | 26.2       | 4.58       | 442        | 15800      | 0.565 J    | 6620       | 18.3 J     | 1120       | 28.5 J     | 420        | NR              |  |
| 01-211-WR-2     | 6.5        | 371 J                        | 0.9 U      | 9.62       | 16.1       | 43.3       | 6780       | 0.156 J    | 1010       | 18.4 J     | 90.7       | 6.27 UJ    | 72.8       | NR              |  |
| BACKGROUND      | 5.13 U     | 221 J                        | 1.0 U      | 3.82       | 4.61       | 6.23       | 7120       | 0.033 U    | 944        | 9.52 J     | 7.03 U     | 6.79 UJ    | 33.6       | NR              |  |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested; \* - From Barringer Laboratory.

| Radiochemistry |                        |                        |                        |                       |                       |                       | Acid/Base Accounting |                                |                          |                                  |                  |                  |                  |                                  |                                  |
|----------------|------------------------|------------------------|------------------------|-----------------------|-----------------------|-----------------------|----------------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| FIELD ID       | Analyte Th-228 (pCi/l) | Analyte Th-230 (pCi/l) | Analyte Th-232 (pCi/l) | Analyte U-234 (pCi/l) | Analyte U-235 (pCi/l) | Analyte U-238 (pCi/l) | TOTAL SULFUR %       | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
| 01-211-WR-1*   | 530 [20]               | 140 [10]               | 510 [20]               | 2.1 [0.7]             | 0.0 [0.2]             | 2.3 [0.7]             | 0.78                 | 24.4                           | 9.63                     | -15                              | 0.08             | 0.22             | 0.48             | 6.87                             | 2.76                             |
| 01-211-WR-2*   | 27 [2]                 | 2.1 [0.6]              | 20 [2]                 | 1.3 [0.5]             | 0.0 [0.2]             | 1.0 [0.5]             | 0.03                 | 0.94                           | 15.6                     | 14.7                             | 0.03             | <0.01            | <0.01            | 0                                | 15.6                             |
| BACKGROUND*    | 1.6 [0.7]              | 1.4 [0.05]             | 1.7 [0.7]              | 0.9 [0.5]             | 0.0 [0.2]             | 0.8 [0.5]             |                      |                                |                          |                                  |                  |                  |                  |                                  |                                  |

[ ] - Plus or minus.

**WATER MATRIX ANALYSES**

| Metals in Water |        |      |        |       |        |        |      |          |      |      |        |        |                 |                | Results in ug/L |  |
|-----------------|--------|------|--------|-------|--------|--------|------|----------|------|------|--------|--------|-----------------|----------------|-----------------|--|
| FIELD ID        | As     | Ba   | Cd     | Co    | Cr     | Cu     | Fe   | Hg       | Mn   | Ni   | Pb     | Sb     | Zn (mg CaCO3/L) | Hardness CALC. |                 |  |
| 01-211-SW-1     | 1.9    | 32.3 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 64.7 | 0.12 UJX | 7.37 | 14   | 3.88 J | 30.7 J | 7.57 U          | 22.7           |                 |  |
| 01-211-SW-2     | 0.96 U | 28.9 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 48.5 | 0.15 JX  | 9.2  | 17.6 | 2.26 J | 30.7 U | 8.9 J           | 20.9           |                 |  |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

| FIELD ID     | Analyte Th-228 (pCi/l) | Analyte Th-230 (pCi/l) | Analyte Th-232 (pCi/l) | Analyte U-234 (pCi/l) | Analyte U-235 (pCi/l) | Analyte U-238 (pCi/l) |
|--------------|------------------------|------------------------|------------------------|-----------------------|-----------------------|-----------------------|
| 01-211-SW-1* | 0.0 [1.1]              | 2.0 [1.5]              | 0.0 [1.0]              | 0.0 [0.8]             | 0.0 [0.5]             | 0.0 [0.5]             |
| 01-211-SW-2* | 0.9 [1.4]              | 1.8 [1.5]              | 0.0 [1.1]              | 0.0 [2.3]             | 0.0 [1.6]             | 0.0 [2.0]             |

[ ] - Plus or minus.

| Wet Chemistry |                        | Results in mg/l |         |           |         |  |  |
|---------------|------------------------|-----------------|---------|-----------|---------|--|--|
| FIELD ID.     | TOTAL DISSOLVED SOLIDS | CHLORIDE        | SULFATE | NO3/NO2-N | CYANIDE |  |  |
| 01-211-SW-1   | 50                     | < 5.0           | < 5     | < 0.05    | NR      |  |  |
| 01-211-SW-2   | 55                     | < 5.0           | < 5     | < 0.05    | NR      |  |  |

SE1 - Downstream on South Frying Pan Creek.  
SE2 - Upstream on South Frying Pan Creek.  
WR1 - South of dump #1; sample of the WR1 subsample.  
WR2 - Northwest side of dump #1; sample of the WR2 subsample.  
BACKGROUND - From the Last Chance #1/IER (01-216-SS-1).

SW1 - Same as sample SE1.  
SW2 - Same as sample SSE2.

**LEGEND**

SE1 - Downstream on South Frying Pan Creek.  
 SE2 - Upstream on South Frying Pan Creek.  
 WR1 - South of dump #1; sample of the WR1 subsample.  
 WR2 - Northwest side of dump #1; sample of the WR2 subsample.  
 BACKGROUND - From the Last Chance #1/TER (01-216-SS-1).

SW1 - Same as sample SE1.  
 SW2 - Same as sample SSE2.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Last Chance No. 1/IER</u>          | County: <u>Beaverhead</u>                         |
| Legal Description: <u>T 10S R 15W</u>                 | Section(s): <u>NE 1/4, NW 1/4, Sec. 29</u>        |
| Mining District: <u>Lemhi Pass</u>                    | Mine Type: <u>Hardrock/Thorium, Uranium</u>       |
| Latitude: <u>N 44° 56' 25"</u>                        | Primary Drainage: <u>North Frying Pan Creek</u>   |
| Longitude: <u>W 113° 28' 12"</u>                      | USGS Code: <u>10020001</u>                        |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>North Frying Pan Creek</u> |
| Quad: <u>Lemhi Pass</u>                               | Date Investigated: <u>August 25, 1993</u>         |
| Inspectors: <u>Bullock, Tuesday</u>                   | P.A. # <u>01-216</u>                              |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- This site was an uranium mine associated with the Last Chance No. 2 (PA# 01-220) and the South Frying Pan Creek (PA# 01-211) mines.
- There were no mill tailings observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 13,000 cubic yards. The following elements were elevated at least three times background:

|                         |                        |
|-------------------------|------------------------|
| Arsenic: 37.4 mg/kg     | Mercury: 4.53J mg/kg   |
| Barium: 4,370J mg/kg    | Manganese: 4,760 mg/kg |
| Cobalt: 18.8 mg/kg      | Lead: 31.1 mg/kg       |
| Copper: 70.6 mg/kg      | Zinc: 149 mg/kg        |
| Thorium-228: 440 pCi/l  | Thorium-230: 150 pCi/l |
| Thorium -232: 420 pCi/l | Uranium-234: 6.8 pCi/l |
| Uranium-238: 7.2 pCi/l  |                        |
- No discharging adits, filled shafts, seeps, or springs were observed at the site during the investigation.
- The nearest surface water drainage was a small intermittent stream bed (dry during the investigation) located approximately 250 feet from toe of dump. No direct runoff pathways from the waste rock dump to the drainage were identified.
- High radiation readings were observed in the open trench (7.0 mR/HR) located above the adit and in the waste rock material (0.90 to 4.0 mR/HR).
- Potential safety hazards associated with the site included a adit with a locked gate, a highwall associated with the trench cut, and a steep and unstable waste rock dump.



**Last Chance #1/IER PA# 01-216**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/25/93**

| SOLID MATRIX ANALYSES  |                              |   |                               |   |                             |                             |                        |   |   |               |               |               |               |                    |
|--|------------------------------|---|-------------------------------|---|-----------------------------|-----------------------------|------------------------|---|---|---------------|---------------|---------------|---------------|--------------------|
| Metals in soils<br>Results per dry weight basis  |                              |   |                               |   |                             |                             |                        |   |   |               |               |               |               |                    |
| FIELD ID   | As<br>(mg/Kg)                | Ba<br>(mg/Kg)                           | Cd<br>(mg/Kg)                 | Co<br>(mg/Kg)                             | Cr<br>(mg/Kg)               | Cu<br>(mg/Kg)               | Fe<br>(mg/Kg)          | Hg<br>(mg/Kg)                             | Mn<br>(mg/Kg)                             | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
| 01-216-WR-1  | 37.4                         | 4370 J                                  | 0.8 U                         | 18.8                                      | 2.63                        | 70.6                        | 9120                   | 4.53 J                                    | 4760                                      | 13 J          | 31.1          | 11.8 J        | 149           | NR                 |
| BACKGROUND   | 5.13 U                       | 221 J                                   | 1.0 U                         | 3.82                                      | 4.61                        | 6.23                        | 7120                   | 0.033 U                                   | 944                                       | 9.52 J        | 7.03 U        | 6.79 UJ       | 33.6          | NR                 |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested; * - From Barringer Laboratory |                              |   |                               |   |                             |                             |                        |   |   |               |               |               |               |                    |
| Radiochemistry   |                              |   |                               |   |                             |                             |                        |   |   |               |               |               |               |                    |
| FIELD ID   | Analyte<br>Th-228<br>(pCi/l) | Analyte<br>Th-230<br>(pCi/l)            | Analyte<br>Th-232<br>(pCi/l)  | Analyte<br>U-234<br>(pCi/l)               | Analyte<br>U-235<br>(pCi/l) | Analyte<br>U-238<br>(pCi/l) |                        |   |   |               |               |               |               |                    |
| 01-216-WR-1*   | 440 [20]                     | 150 [10]                                | 420 [20]                      | 6.8 [1.1]                                 | 0.1 [0.3]                   | 7.2 [1.2]                   |                        |   |   |               |               |               |               |                    |
| BACKGROUND*  | 1.6 [0.7]                    | 1.4 [0.05]                              | 1.7 [0.7]                     | 0.9 [0.5]                                 | 0.0 [0.2]                   | 0.8 [0.5]                   |                        |   |   |               |               |               |               |                    |
| [ ] - Plus or minus.   |                              |   |                               |   |                             |                             |                        |   |   |               |               |               |               |                    |
| Acid/Base Accounting   |                              |   |                               |   |                             |                             |                        |   |   |               |               |               |               |                    |
| FIELD ID   | TOTAL<br>SULFUR<br>%         | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>%      | PYRITIC<br>SULFUR<br>%      | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |               |               |               |               |                    |
| 01-216-WR-1  | 0.49                         | 15.3                                    | 20.1                          | 4.8                                       | 0.03                        | 0.04                        | 0.42                   | 1.25                                      | 18.9                                      |               |               |               |               |                    |

**LEGEND**

WR1 - Composite of subsamples WR1A and 1B.

BACKGROUND - From the Last Chance #1/IER (01-216-SS-1).

**LEGEND**

WR1 - Composite of subsamples WR1A and 1B.  
BACKGROUND - From the Last Chance #1/IER (01-216-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Last Chance No. 2/IER</u>          | County: <u>Beaverhead</u>                         |
| Legal Description: <u>T 10S R 15W</u>                 | Section(s): <u>SW 1/4, NE 1/4, Sec. 29</u>        |
| Mining District: <u>Lemhi Pass</u>                    | Mine Type: <u>Hardrock/Thorium, rare earths</u>   |
| Latitude: <u>N 45° 56' 08"</u>                        | Primary Drainage: <u>Frying Pan Creek</u>         |
| Longitude: <u>W 113° 27' 48"</u>                      | USGS Code: <u>10020001</u>                        |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>South Frying Pan Creek</u> |
| Quad: <u>Lemhi Pass</u>                               | Date Investigated: <u>August 25, 1993</u>         |
| Inspectors: <u>Bullock, Tuesday</u>                   | P.A. # <u>01-220</u>                              |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- This site was an uranium mine associated with the Last Chance No. 1 (PA# 01-216) and the South Frying Pan Creek (PA# 01-211) mines.
- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 11,000 cubic yards. The following elements were elevated at least three times background:

|                        |                        |
|------------------------|------------------------|
| Arsenic: 82.1 mg/kg    | Lead: 22.5 mg/kg       |
| Copper: 84.1 mg/kg     | Antimony: 21.5 mg/kg   |
| Mercury: 0.104J mg/kg  | Thorium-228: 61 pCi/l  |
| Thorium-230: 5 pCi/l   | Thorium-232: 66 pCi/l  |
| Uranium-234: 4.4 pCi/l | Uranium-238: 4.3 pCi/l |
- No discharging adits, filled shafts, seeps, or springs were observed at the site during the investigation.
- South Frying Pan Creek was flowing approximately 100 feet south of the site; however, no surface water samples were collected due to lack of a direct runoff pathway from the waste rock dump to the creek.
- Relatively high radiation readings (0.30 mR/HR) were observed in the waste rock dump at this site.
- One potentially hazardous collapsing shack was identified at the site.

**Last Chance #2/IER PA# 01-220**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/26/93**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 01-220-WR-1 | 82.1          | 429 J         | 0.8 U         | 8.15          | 8.38          | 84.1          | 13400         | 0.104 J       | 200           | 12.6 J        | 22.5          | 21.5 J        | 19.2          | NR                 |
| BACKGROUND  | 5.13 U        | 221 J         | 1.0 U         | 3.82          | 4.61          | 6.23          | 7120          | 0.033 U       | 944           | 9.52 J        | 7.03 U        | 6.79 UJ       | 33.6          | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested; \* - From Barringer Lab.

**Radiochemistry**

| FIELD ID     | Analyte<br>Th-228<br>(pCi/l) | Analyte<br>Th-230<br>(pCi/l) | Analyte<br>Th-232<br>(pCi/l) | Analyte<br>U-234<br>(pCi/l) | Analyte<br>U-235<br>(pCi/l) | Analyte<br>U-238<br>(pCi/l) |
|--------------|------------------------------|------------------------------|------------------------------|-----------------------------|-----------------------------|-----------------------------|
| 01-220-WR-1* | 61 [6]                       | 5 [1.8]                      | 66 [6]                       | 4.4 [0.9]                   | 0.0 [0.2]                   | 4.3 [0.9]                   |
| BACKGROUND*  | 1.6 [0.7]                    | 1.4 [0.05]                   | 1.7 [0.7]                    | 0.9 [0.5]                   | 0.0 [0.2]                   | 0.8 [0.5]                   |

[ ] - Plus or minus

**Acid/Base Accounting**

| FIELD ID    | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|----------------------|---|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 01-220-WR-1 | 0.01                 | 0.31                                    | 13.8                          | 13.5                                      | 0.01                   | <0.01                  | <0.01                  | 0   | 13.8                                      |

**LEGEND**

WR1 - Composite of subsamples WR1A through 1C.  
BACKGROUND - From the Last Chance #1/IER (01-216-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Tungsten Millsite</u>              | County: <u>Beaverhead</u>                                 |
| Legal Description: <u>T 4S R 9W</u>                   | Section(s): <u>SW 1/4, Sec. 4; SE 1/4, SE 1/4, Sec. 5</u> |
| Mining District: <u>Lost Creek</u>                    | Mine Type: <u>Millsite/Tungsten</u>                       |
| Latitude: <u>N 45° 30' 45"</u>                        | Primary Drainage: <u>Big Hole River</u>                   |
| Longitude: <u>W 112° 43' 45"</u>                      | USGS Code: <u>10020004</u>                                |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Sassman Gulch</u>                  |
| Quad: <u>Earls Gulch</u>                              | Date Investigated: <u>September 13, 1993</u>              |
| Inspectors: <u>Bullock/Pierson</u>                    | P.A. # <u>01-170</u>                                      |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- The volume of tailings associated with this site was estimated to be approximately 448,000 cubic yards. A heavy petroleum odor was observed in the lower clay of TP-4 (Total Petroleum Hydrocarbons = 611 mg/kg). The following elements were elevated at least three times background:

|                               |                                  |
|-------------------------------|----------------------------------|
| Barium: 2620 mg/kg            | Manganese: 4,380 to 14,900 mg/kg |
| Cadmium: 2.81 mg/kg           | Lead: 123 mg/kg                  |
| Copper: 107 to 567 mg/kg      | Antimony: 19.9 mg/kg             |
| Mercury: 0.054 to 0.475 mg/kg | Zinc: 468 mg/kg                  |
- The volume of waste rock associated with this site was estimated to be approximately 11,700 cubic yards. The following elements were elevated at least three times background:

|                      |                       |
|----------------------|-----------------------|
| Copper: 2380 mg/kg   | Antimony: 18.5 mg/kg  |
| Mercury: 0.054 mg/kg | Manganese: 2310 mg/kg |
- The site was partially reclaimed in 1990.
- Several residences were located in close proximity to the site. Groundwater sample were collected from residential well located directly downgradient from the site and one directly upgradient from the site. Total petroleum hydrocarbons were measured at 23.3 mg/L in the downgradient well (GW-1). No MCLs were exceeded in either of the wells; however, the chronic aquatic life criteria for mercury was exceeded in the upgradient well (GW-2). Additionally, an observed release to groundwater was documented for barium, which was directly attributable to the site.
- No surface water was observed on or near the site during the investigation, intermittent Sassman Gulch (dry during the investigation) was located more than 1,000 feet south of the site; consequently, no surface water samples were collected.
- Potential safety hazards identified at the site include a 15 feet tall loadout wall and an eroding tailings pile (TP-6); however, the majority of the site was surrounded by a fence.



**Tungsten Millsite PA# 01-170**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 09/13/93**

## SOLID MATRIX ANALYSES

| Metals in soils |               | Results per dry weight basis |               |               |               |               |               |               |               |               |               |               |               |   |
|-----------------|---------------|------------------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---|
| FIELD ID        | As<br>(mg/Kg) | Ba<br>(mg/Kg)                | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | Total Petroleum Hydrocarbons<br>(mg/Kg) |
| 01-170-TP-1     | 7.5 J         | 89.2                         | 0.89 U        | 7.35          | 11.6          | 107           | 32500         | 0.055 J       | 4380          | 10.1          | 17.9          | 6.39 J        | 119           | NR                                      |
| 01-170-TP-2     | 107 J         | 2620                         | 0.73          | 17.8          | 7.94          | 123           | 17600         | 0.475 J       | 14900         | 29.5          | 35.1          | 19.9 J        | 79.6          | NR                                      |
| 01-170-TP-3     | 5.58 J        | 88.9                         | 1.48          | 7.5           | 9.78          | 189           | 38200         | 0.087 J       | 4670          | 10.4          | 31.5          | 6.59 UJ       | 125           | NR                                      |
| 01-170-TP-4     | 12.6 J        | 41.6                         | 2.81          | 12.7          | 15.5          | 567           | 62500         | 0.143 J       | 5310          | 16.5          | 123           | 6.78 UJ       | 154           | 611                                     |
| 01-170-TP-5     | 8.03 J        | 134                          | 1.72          | 16.2          | 16.5          | 331           | 47900         | 0.072 J       | 7000          | 21.8          | 7.36          | 10.5 J        | 468           | NR                                      |
| 01-170-WR-1     | 6.28 J        | 40.9                         | 2.29          | 9.59          | 6.08          | 2380          | 28600         | 0.055 J       | 2310          | 10.7          | 8.87          | 18.5 J        | 323           | NR                                      |
| BACKGROUND      | 56            | 169                          | 0.8 JX        | 13.8          | 29.4          | 34.2          | 25300         | 0.014 U       | 462           | 26            | 30            | 4 UJ          | 119           | NR                                      |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

## Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE<br>#/1000t | NEUTRAL POTENT.<br>#/1000t | SULFUR ACID BASE<br>#/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE<br>#/1000t | SULFUR ACID BASE<br>#/1000t |
|-------------|----------------|-----------------------------------|----------------------------|-----------------------------|------------------|------------------|------------------|-------------------------------------|-----------------------------|
| 01-170-TP-1 | <0.01          | 0                                 | 165                        | 165                         | <0.01            | <0.01            | 0.02             | 0                                   | 165                         |
| 01-170-TP-2 | <0.01          | 0                                 | 47.7                       | 47.7                        | <0.01            | <0.01            | <0.01            | 0                                   | 47.7                        |
| 01-170-TP-3 | 0.01           | 0.31                              | 125                        | 125                         | <0.01            | <0.01            | 0.01             | 0                                   | 125                         |
| 01-170-TP-4 | 0.03           | 0.94                              | 135                        | 134                         | 0.01             | <0.01            | 0.02             | 0                                   | 135                         |
| 01-170-TP-5 | 0.06           | 1.87                              | 206                        | 204                         | 0.05             | <0.01            | 0.01             | 0                                   | 206                         |
| 01-170-WR-1 | <0.01          | 0                                 | 131                        | 131                         | <0.01            | <0.01            | <0.01            | 0                                   | 131                         |

## WATER MATRIX ANALYSES

| FIELD ID    | Metals in Water |      | Results in ug/L |     |        |        |      |        |        |        |        |        |        | HARDNESS CALC.<br>(mg CaCO3/L) |
|-------------|-----------------|------|-----------------|-----|--------|--------|------|--------|--------|--------|--------|--------|--------|--------------------------------|
|             | As              | Ba   | Cd              | Co  | Cr     | Cu     | Fe   | Hg     | Mn     | Ni     | Pb     | Sb     | Zn     |                                |
| 01-170-GW-1 | 3.39            | 97.5 | 4.59 U          | 5 U | 6.24 U | 2.33 U | 53.1 | 0.12 U | 3.76 U | 10.9 U | 1.22 U | 31.7 U | 8.71 U | 309                            |
| 01-170-GW-2 | 2.09            | 29.1 | 4.59 U          | 5 U | 6.24 U | 2.33 U | 24.4 | 0.15 J | 4.6    | 10.9 U | 2.17   | 31.7 U | 69.3   | 175                            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

## Wet Chemistry

**Results in mg/l**

| FIELD<br>I.D. | TOTAL<br>DISSOLVED<br>SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | TOTAL<br>PETROLEUM<br>HYDROCARBONS<br>(mg/L) |
|---------------|------------------------------|----------|---------|-----------|--|
| 01-170-GW-1   | 408                          | 31       | 60      | 0.64      | 23.3   |
| 01-170-GW-2   | 234                          | 9        | 16      | 0.4       | NR   |

## LEGEND

TP1 - Composite of subsamples TP1A, 1B, and 1D.

TP2 - Sample of the TP1C subsample.

TP3 - Composite of subsamples TP2A, 2B, 2C, 3A, 3B, 3C, 4A, and 4B.

TP4 - Sample of the TP4C subsample.

TP5 - Sample of the TP6A subsample.

WR1 - Composite of subsamples WR1A and 1B.

BACKGROUND - From the Emma Mine (29-061-SS-1).

GW1 - Downgradient sample at trailor, below tailings pond 8.

GW2 - Water supply well for mill; converted to residence.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Clara</u>                          | County: <u>Beaverhead</u>                  |
| Legal Description: T <u>3S</u> R <u>14W</u>           | Section(s): <u>NE 1/4, NW 1/4, Sec. 18</u> |
| Mining District: <u>Wisdom</u>                        | Mine Type: <u>Hardrock/Unknown</u>         |
| Latitude: <u>N 45° 34' 43"</u>                        | Primary Drainage: <u>Sleek Creek</u>       |
| Longitude: <u>W 113° 22' 38"</u>                      | USGS Code: <u>10020004</u>                 |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Dry Gulch</u>       |
| Quad: <u>Highland Ranch</u>                           | Date Investigated: <u>August 13, 1993</u>  |
| Inspectors: <u>Bullock, Tuesday, Belanger</u>         | P.A. # <u>01-262</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no mill tailings identified to be associated with this site.
- The volume of waste rock associated with this site was estimated to be approximately 2,185 cubic yards. The following elements were elevated at least three times background:

|                     |                    |
|---------------------|--------------------|
| Barium: 622 mg/kg   | Mercury: 1.1 mg/kg |
| Cadmium: 6.1J mg/kg | Lead: 145 mg/kg    |
| Copper: 86.8 mg/kg  | Iron: 39,300 mg/kg |
| Zinc: 995 mg/kg     |                    |
- There was one discharging adit identified at this site and it was characterized by sample GW-1. The pH of GW-1 was 7.02 and specific conductance was 240 umhos/cm. No MCLs or MCLGs were exceeded. The acute aquatic life criteria for cadmium was exceeded. Chronic aquatic life criteria were exceeded for lead. The adits discharge flows over a portion of Waste Rock Dump #1, prior to seeping back into the ground.
- Two surface water samples were collected from Dry Gulch, one up gradient and one down gradient represented by SW-2 and SW-1 respectively. Observed releases were documented for copper, iron, lead and zinc, all directly attributable to this site. The MCL/MCLG for lead was exceeded in SW-1. The acute aquatic life standard for iron and zinc were exceeded in SW-1. Chronic aquatic life criteria were exceeded for copper and zinc in SW-1.
- Several safety hazards were found to be present at this site including the collapsed shaft, a structure near the shaft, and a cabin. Access to this site was unrestricted.

**Clara PA# 01-262**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/13/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 01-262-SE-1 | 7 U        | 173        | 1 J        | 4.5        | 5.8        | 8.3        | 11800      | 0.061 U    | 249        | 4 U        | 12 U       | 9 U        | 49         | NR              |
| 01-262-SE-2 | 8 U        | 48.5       | 0.8 U      | 3.1 U      | 2.6        | 2.6        | 6390       | 0.045 U    | 140        | 4 U        | 14         | 10 U       | 40         | NR              |
| 01-262-WR-1 | 14 U       | 622        | 6.1 J      | 6.6        | 4.1 U      | 86.8       | 39300      | 1.1        | 1990       | 8          | 145        | 18 U       | 995        | NR              |
| BACKGROUND  | 6          | 178        | 0.5 U      | 4.5        | 4          | 3.4        | 11400      | 0.027 U    | 880        | 4          | 10         | 6 U        | 62         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID       | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|----------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 01-262-WR-1DUP | 0.01           | 0.31                           | 33.0                     | 32.7                             | 0.01             | <0.01            | 0.01             | 0.00                             | 33.0                             |
| 01-262-WR-1    | <0.01          | 0.00                           | 32.4                     | 32.4                             | <0.01            | <0.01            | <0.01            | 0.00                             | 32.4                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba  | Cd     | Co    | Cr     | Cu     | Fe   | Hg    | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|-----|--------|-------|--------|--------|------|-------|------|--------|--------|--------|-----------------|----------------|
| 01-262-GW-1 | 2.64 | 153 | 3.27   | 9.7 U | 6.83 U | 7.7 J  | 162  | 0.160 | 87.7 | 12.7 U | 2.62   | 30.7 U | 40.7            | 84             |
| 01-262-SW-1 | 9.37 | 140 | 2.57 U | 9.7 U | 6.83 U | 17.2 J | 3100 | 0.250 | 434  | 165    | 2.32   | 30.7 U | 204             | 122            |
| 01-262-SW-2 | 2.15 | 49  | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 203  | 0.180 | 6.97 | 12.7 U | 0.72 U | 30.7 U | 7.57 U          | 57.4           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID.   | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 01-262-GW-1 | 209                    | 5.0      | 23      | < 0.05    | NR      |
| 01-262-SW-1 | 330                    | 10.0     | 15      | < 0.05    | NR      |
| 01-262-SW-2 | 181                    | 8.0      | 22      | < 0.05    | NR      |

**LEGEND**

SE1 - Downgradient of site on Dry Gulch.  
SE2 - Upgradient of site in Dry Gulch.  
WR1 - Composite of subsamples WR1A, 1B, 2, and 3.  
BACKGROUND - From the Clara Mine (01-262-SS-1).  
WR1DUP - Duplicate of the 01-262-WR-1 sample.

GW1 - Discharge from adit associated with waste rock dump 3.  
SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Martin</u>                         | County: <u>Beaverhead</u>                         |
| Legal Description: <u>T 3S R 13W</u>                  | Section(s): <u>NE 1/4, NW 1/4, Sec. 19</u>        |
| Mining District: <u>Wisdom</u>                        | Mine Type: <u>Hardrock/Cu, Pb, Ag, Au</u>         |
| Latitude: <u>N 45° 33' 32"</u>                        | Primary Drainage: <u>Warm Spring Creek</u>        |
| Longitude: <u>W 113° 15' 23"</u>                      | USGS Code: <u>10020004</u>                        |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>E. Fk. Warm Spring Ck.</u> |
| Quad: <u>Stewart Mountain</u>                         | Date Investigated: <u>September 9, 1993</u>       |
| Inspectors: <u>Bullock, Tuesday</u>                   | P.A. # <u>01-270</u>                              |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no mill tailings found to be associated with this site.
- The volume of waste rock associated with this site was estimated at 1,100 cubic yards. The following elements were elevated at least three times background:

|                     |                     |
|---------------------|---------------------|
| Arsenic: 15.6 mg/kg | Lead: 1850 mg/kg    |
| Cadmium: 10.8 mg/kg | Antimony: 18J mg/kg |
| Copper: 177J mg/kg  | Zinc: 1240 mg/kg    |
| Mercury: 9.26 mg/kg |                     |
- There was one discharging adit identified at this site. The flow was approximately 1.5 gpm with a pH of 6.9. No MCLs or MCLGs were exceeded. Acute and chronic aquatic life criteria were exceeded for cadmium, copper, lead, and zinc.
- The East Fork of Warm Spring Creek flowed along the western end of this site. An observed release was documented for zinc. The acute aquatic life criteria were exceeded for copper and zinc, and the chronic aquatic life criteria were exceeded for zinc; these exceedances were attributable to the site.
- There were six standing or partially collapsed cabins at this site that present a safety hazard.



**Martin PA# 01-270**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 09/09/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 01-270-SE-1 | 6.24 U        | 49.5 J        | 0.7 U         | 3.71 J        | 1.76          | 5.86 J        | 11800         | 0.104         | 285 J         | 3.35 U        | 27.9          | 8.13 UJ       | 52.5          | NR                 |
| 01-270-SE-2 | 4.67 U        | 79.1 J        | 0.5 U         | 4.97 J        | 2.28          | 3.57 J        | 11300         | 0.038 U       | 321 J         | 2.51 U        | 8.01 U        | 6.09 UJ       | 33.7          | NR                 |
| 01-270-WR-1 | 15.6          | 143 J         | 10.8          | 5.41 J        | 2.08          | 177 J         | 12100         | 9.26          | 398 J         | 1.86 U        | 1850          | 18 J          | 1240          | NR                 |
| BACKGROUND  | 5.08          | 84.5 J        | 0.4 U         | 6.91 J        | 10.1          | 7.2 J         | 12500         | 0.031 U       | 403 J         | 3.54          | 6.85 U        | 5.21 UJ       | 37.8          | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 01-270-WR-1 | 0.01              | 0.31                                 | 9.45                          | 9.14                                      | <0.01                  | <0.01                  | 0.01                   | 0   | 9.45                                      |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As      | Ba   | Cd     | Co    | Cr     | Cu     | Fe   | Hg   | Mn      | Ni     | Pb   | Sb       | Zn (mg CaCO3/L) | HARDNESS<br>CALC. |
|-------------|---------|------|--------|-------|--------|--------|------|------|---------|--------|------|----------|-----------------|-------------------|
| 01-270-GW-1 | 3.72 JX | 20.2 | 2.7    | 9.7 U | 6.83 U | 23.3   | 767  | 0.28 | 59.2    | 12.7 U | 53   | 30.7 UJX | 162             | 17.8              |
| 01-270-SW-1 | 3.18 JX | 8.4  | 2.57 U | 9.7 U | 6.83 U | 2.13   | 633  | 0.15 | 24.5    | 12.7 U | 1.78 | 30.7 UJX | 26.4            | 10.3              |
| 01-270-SW-2 | 1.34 JX | 4.7  | 2.57 U | 9.7 U | 6.87   | 1.55 U | 24.8 | 0.17 | 4.08 UJ | 12.7 U | 2.9  | 30.7 UJX | 7.57 U          | 8.4               |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED<br>SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|---------------------------|----------|---------|-----------|---------|
| 01-270-GW-1 | 81                        | < 5.0    | < 5.0   | 0.12      | NR      |
| 01-270-SW-1 | 55                        | < 5.0    | < 5.0   | < 0.05    | NR      |
| 01-270-SW-2 | 47                        | < 5.0    | < 5.0   | < 0.05    | NR      |

**LEGEND**

SE1 - Downstream of waste rock dump 3 on East Fork Warm Spring Creek.  
SE2 - Upstream of site on East Fork Warm Spring Creek.  
WR1 - Composite of subsamples WR1A, 1B, 2, 3A, and 3B.  
BACKGROUND - From the Martin Mine (01-270-SS-1).

GW1 - Large collapsed adit in drainage.  
SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Miller</u>                         | County: <u>Broadwater</u>                  |
| Legal Description: T <u>10N</u> R <u>2E</u>           | Section(s): <u>SW 1/4, SE 1/4, Sec. 13</u> |
| Mining District: <u>Confederate</u>                   | Mine Type: <u>Hardrock/Au</u>              |
| Latitude: <u>N 46° 37' 12"</u>                        | Primary Drainage: <u>Confederate Gulch</u> |
| Longitude: <u>W 111° 24' 58"</u>                      | USGS Code: <u>10030101</u>                 |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Greenhorn Gulch</u> |
| Quad: <u>Diamond City</u>                             | Date Investigated: <u>July 26, 1993</u>    |
| Inspectors: <u>Babits, Flammang, Lasher</u>           | P.A. # <u>04-138</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no tailings on site.
- There were approximately 11,950 cubic yards of mostly uncovered waste rock on site. The following were elevated at least three times background:

|                              |                               |
|------------------------------|-------------------------------|
| Cadmium: 3.2 to 4.1 mg/kg    | Copper: 91.8 to 2,520 mg/kg   |
| Iron: 52,600 to 54,600 mg/kg | Mercury: 1.57J to 2.46J mg/kg |
| Manganese: 1,540 mg/kg       | Lead: 89 to 2,960 mg/kg       |
| Zinc: 250 mg/kg              |                               |
- There was a discharging adit on site that entered the gulch; the pH measurement was 5.23. The MCL for nickel and the acute and chronic aquatic life criteria for copper and zinc were exceeded in the adit discharge. Additionally, the chronic aquatic life criteria for iron and mercury were exceeded in the adit discharge.
- Adit discharge flowed over waste rock and made up the entire flow of Greenhorn Gulch. The gulch flowed into Confederate Gulch 1.5 miles away.
- There were several open or partially open adits and hazardous structures on site.

**Miller PA# 04-138**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/26/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 04-138-SE-1 | 9          | 109        | 1.6        | 8.6        | 16.1       | 30.3       | 27100      | 0.221 J    | 365        | 21 J       | 59         | 7 UJ       | 125        | NR              |
| 04-138-WR-1 | 10         | 152        | 1.6        | 5.5        | 7.4        | 91.8       | 29200      | 1.57 J     | 247        | 14 J       | 135        | 7 UJ       | 102        | NR              |
| 04-138-WR-2 | 24         | 156        | 3.2        | 13.5       | 5.2        | 902        | 54600      | 2.46 J     | 452        | 10 J       | 89         | 6 UJ       | 59         | NR              |
| 04-138-WR-3 | 27         | 293        | 4.1        | 13.8       | 8.3        | 2520       | 52600      | 2.39 J     | 1540       | 26 J       | 2960       | 6 UJ       | 250        | NR              |
| BACKGROUND  | 20         | 98.5       | 0.8        | 5.8        | 11.9       | 21.6       | 14100      | 0.042 J    | 419        | 10 J       | 22         | 6 UJ       | 66         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE $\mu$ /1000t | NEUTRAL POTENT. $\mu$ /1000t | SULFUR ACID BASE POTENT. $\mu$ /1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE $\mu$ /1000t | SULFUR ACID BASE POTENT. $\mu$ /1000t |
|-------------|----------------|-------------------------------------|------------------------------|---------------------------------------|------------------|------------------|------------------|---------------------------------------|---------------------------------------|
| 04-138-WR-1 | 1.38           | 43.1                                | 48.6                         | 5.45                                  | 0.46             | 0.59             | 0.33             | 18.4                                  | 30.1                                  |
| 04-138-WR-2 | 0.57           | 17.8                                | 32.1                         | 14.3                                  | 0.14             | 0.16             | 0.27             | 5.00                                  | 27.1                                  |
| 04-138-WR-3 | 0.24           | 7.50                                | 21.4                         | 13.9                                  | 0.12             | 0.06             | 0.06             | 1.87                                  | 19.5                                  |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As | Ba     | Cd     | Co   | Cr     | Cu  | Fe    | Hg   | Mn     | Ni  | Pb   | Sb     | Zn   | HARDNESS CALC. (mg CaCO <sub>3</sub> /L) |
|-------------|----|--------|--------|------|--------|-----|-------|------|--------|-----|------|--------|------|--|
| 04-138-SW-1 | 1  | 2.01 U | 2.57 U | 78.8 | 6.83 U | 189 | 83300 | 0.13 | 7000 J | 145 | 7.03 | 30.7 U | 1920 | 1090                                     |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO <sub>3</sub> /NO <sub>2</sub> -N | CYANIDE |
|-------------|------------------------|----------|---------|-------------------------------------|---------|
| 04-138-SW-1 | 1810                   | < 5.0    | 1160    | < 0.05                              | NR      |

**LEGEND**

SE1 - 500 feet from waste rock dump 1 in Greenhorn Gulch.  
WR1 - Composite of subsamples WR1, 2A, and 2B.  
WR2 - Composite of subsamples WR3A, 3B, and 3C.  
WR3 - Composite of subsamples WR4, 5, and 6.  
BACKGROUND - From the Hummingbird Mine (04-144-S5-1).

SW1 - Discharge from adit #1.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Hummingbird</u>                    | County: <u>Broadwater</u>                  |
| Legal Description: T <u>10N</u> R <u>2E</u>           | Section(s): <u>SE 1/4, NE 1/4, Sec. 13</u> |
| Mining District: <u>Confederate</u>                   | Mine Type: <u>Hardrock/Au, Ag</u>          |
| Latitude: <u>N 46° 37' 40"</u>                        | Primary Drainage: <u>White Creek</u>       |
| Longitude: <u>W 111° 24' 45"</u>                      | USGS Code: <u>10030101</u>                 |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Johnnys Gulch</u>   |
| Quad: <u>Whites City</u>                              | Date Investigated: <u>July 26, 1993</u>    |
| Inspectors: <u>Babits, Flammang, Lasher</u>           | P.A. # <u>04-144</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no tailings on site.
- There were approximately 4,360 cubic yards of mostly covered waste rock on site. The following were elevated at least three times background:  
Mercury: 2.17J mg/kg  
Nickel: 39J mg/kg  
Lead: 77 mg/kg
- There was a discharging adit on site that did not have a surface route to water. The pH of this sample was 7.64. No MCLs/MCLGs were exceeded; however, the chronic aquatic life criteria for mercury was exceeded in the adit discharge
- There was no surface water on site. No surface water or sediment samples were collected.
- There were no hazardous openings or structures on site.



**Hummingbird PA# 04-144**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/26/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 04-144-WR-1 | 17            | 157           | 2.1           | 10            | 10.4          | 49.6          | 31300         | 2.17 J        | 570           | 39 J          | 77            | 5 UJ          | 87            | NR                 |
| BACKGROUND  | 20            | 98.5          | 0.8           | 5.8           | 11.9          | 21.6          | 14100         | 0.042 J       | 419           | 10 J          | 22            | 6 UJ          | 66            | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 04-144-WR-1 | 0.31              | 9.68                                 | 39.2                          | 29.5                                      | 0.02                   | 0.12                   | 0.17                   | 3.75                                      | 35.5                                      |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu     | Fe  | Hg   | Mn     | Ni     | Pb   | Sb     | Zn<br>(mg CaCO3/L) | HARDNESS<br>CALC. |
|-------------|--------|------|--------|-------|--------|--------|-----|------|--------|--------|------|--------|--------------------|-------------------|
| 04-144-SW-1 | 0.96 U | 15.3 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 236 | 0.12 | 7.07 J | 12.7 U | 3.09 | 30.7 U | 7.57 U             | 231               |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED<br>SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|---------------------------|----------|---------|-----------|---------|
| 04-144-SW-1 | NR                        | NR       | NR      | 0.11      | NR      |

**LEGEND**

WR1 - Composite of subsamples WR1, 2, 3 and 4.

SW1 - Adit discharge (North of cabin).

BACKGROUND - 50 feet up from adit #1 from Hummingbird Mine (04-144\_SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |  |
|--|--|
| Mine/Site Name: <u>Argo Mine and Millsite</u>  | County: <u>Broadwater</u>                  |
| Legal Description: <u>T 11N R 1E</u>   | Section(s): <u>NW 1/4, NE 1/4, Sec. 27</u> |
| Mining District: <u>Hellgate</u>   | Mine Type: <u>Hardrock/Cu</u>              |
| Latitude: <u>N 46° 41' 16"</u>   | Primary Drainage: <u>Missouri River</u>    |
| Longitude: <u>W 111° 33' 52"</u>   | USGS Code: <u>10030101</u>                 |
| Land Status: <u>Private/Public</u>   | Secondary Drainage: <u>Hellgate Gulch</u>  |
| Quad: <u>Hellgate Gulch</u>  | Date Investigated: <u>July 26, 1993</u>    |
| Inspectors: <u>Bullock, Clark/Pierson</u>  | P.A. # <u>04-015</u>                       |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |  |

- The volume of tailings associated with this site was estimated to be 9,000 cubic yards. The following elements were elevated at least three times background:  
Copper: 7,810 mg/kg  
Mercury: 0.562J mg/kg
- The volume of waste rock associated with this site was estimated to be 14,400 cubic yards. The following elements were elevated at least three times background:  
Cadmium: 2.2 mg/kg  
Copper: 58,200 mg/kg  
Iron: 55,100 mg/kg  
Mercury: 0.511J mg/kg  
Nickel: 31J mg/kg  
Lead: 59 mg/kg
- There were no adit discharges, seeps or springs identified at this site.
- Hellgate Gulch Creek was flowing through and around this site. Storm water was observed running off the tailings directly into Hellgate Creek. Surface water samples were collected from Hellgate Creek above the site and below the majority of the workings, just upstream from the Harris Gulch confluence. An observed release was documented for copper. No MCL/MCLGs were exceeded. In addition, no acute or chronic aquatic life criteria were exceeded.
- Adit #1 did have a gate, but it was not locked and was determined to present a potential safety hazard. The mill and the cabin at WR-2 were identified as hazardous structures.

**Argo PA# 04-015**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/26/93**

| SOLID MATRIX ANALYSES                           |               |               |               |               |               |               |               |               |               |               |               |               |               |                    |
|---|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| Metals in soils<br>Results per dry weight basis |               |               |               |               |               |               |               |               |               |               |               |               |               |                    |
| FIELD ID  | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
| 04-015-SE-1                                     | 11            | 33.7          | 0.9           | 4.3           | 6.9           | 2240          | 15400         | 0.013 J       | 299           | 12 J          | 22            | 6 UJ          | 42            | NR                 |
| 04-015-SE-2                                     | 8             | 39.7          | 0.9           | 5.4           | 5.9           | 14.8          | 14900         | 0.017 J       | 244           | 12 J          | 19            | 6 UJ          | 54            | NR                 |
| 04-015-TP-1                                     | 5             | 35.6          | 1.4           | 4.4           | 3.1           | 7810          | 18000         | 0.562 J       | 286           | 8 J           | 30            | 7 UJ          | 25            | NR                 |
| 04-015-WR-1                                     | 14            | 34.1          | 2.2           | 6.8           | 5.2           | 58200         | 55100         | 0.511 J       | 201           | 31 J          | 59            | 6 UJ          | 40            | NR                 |
| BACKGROUND                                      | 16            | 225           | 0.6           | 4.7           | 4.5           | 52.4          | 8640          | 0.023 J       | 410           | 5 J           | 14            | 7 UJ          | 39            | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

| Acid/Base Accounting |                |                                |                         |                                  |                  |                  |                  |                                  |                                  |
|----------------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| FIELD ID             | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
| 04-015-TP-1          | 0.99           | 30.9                           | 77.9                    | 47.0                             | <0.01            | 0.04             | 0.97             | 1.25                             | 76.6                             |
| 04-015-WR-1          | 1.14           | 35.6                           | 62.9                    | 27.3                             | <0.01            | 0.22             | 1.06             | 6.87                             | 56.0                             |

| WATER MATRIX ANALYSES              |        |      |        |       |        |        |     |      |        |        |      |        |                 |          |
|------------------------------------|--------|------|--------|-------|--------|--------|-----|------|--------|--------|------|--------|-----------------|----------|
| Metals in Water<br>Results in ug/L |        |      |        |       |        |        |     |      |        |        |      |        |                 | HARDNESS |
| FIELD ID                           | As     | Ba   | Cd     | Co    | Cr     | Cu     | Fe  | Hg   | Mn     | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | CALC.    |
| 04-015-SW-1                        | 0.96 U | 29.6 | 2.57 U | 9.7 U | 6.83 U | 22.9   | 388 | 0.09 | 14.8 J | 12.7 U | 3.34 | 30.7 U | 7.57 U          | 318      |
| 04-015-SW-2                        | 0.96 U | 25.5 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 220 | 0.14 | 10.2 J | 12.7 U | 2.45 | 30.7 U | 7.57 U          | 314      |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

| Wet Chemistry<br>Results in mg/l |                        |          |         |           |         |
|----------------------------------|------------------------|----------|---------|-----------|---------|
| FIELD ID                         | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
| 04-015-SW-1                      | 380                    | < 5.0    | 59      | < 0.05    | NR      |
| 04-015-SW-2                      | 349                    | 5.7      | 53      | < 0.05    | NR      |

**LEGEND**

SE1 - Downgradient from most of the site, but upgradient of Harris Gulch confluence.

SE2 - Upgradient of site; 200' above trail head.

TP1 - Composite of subsamples TP1A-A, 1A-B, 1A-C, 1B-A, 1B-B, and 1B-C.

WR1 - Composite of subsamples WR1A, 1B, and 2A.

BACKGROUND - From the Argo (04-015-SS-1).

SW1 - Same as sample SE1.

SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |  |
|--|--|
| Mine/Site Name: <u>Park</u>  | County: <u>Broadwater</u>                  |
| Legal Description: T <u>7N</u> R <u>1W</u>   | Section(s): <u>NE 1/4, NE 1/4, Sec. 15</u> |
| Mining District: <u>Indian Creek</u>   | Mine Type: <u>Hardrock/Au, Pb, Ag</u>      |
| Latitude: <u>N 46° 21' 53"</u>   | Primary Drainage: <u>Indian Creek</u>      |
| Longitude: <u>W 111° 42' 21"</u>   | USGS Code: <u>10030101</u>                 |
| Land Status: <u>Private/Public</u>   | Secondary Drainage: <u>Indian Creek</u>    |
| Quad: <u>Giant Hill</u>  | Date Investigated: <u>July 27, 1993</u>    |
| Inspectors: <u>Bullock, Clark/Pierson</u>  | P.A. # <u>04-012</u>                       |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |  |

- The volume of tailings associated with this site was estimated to be 60 cubic yards. The impoundments were breached and the majority of the volume of tailings have washed down the drainage. The following elements were elevated at least three times background:  
Arsenic: 1,260J mg/kg                      Lead: 4,160 mg/kg  
Cyanide was also at 0.292U mg/kg.
- The volume of waste rock associated with this site was estimated to be approximately 65,000 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 4,730J to 9,820J mg/kg              Mercury: 0.59J to 0.713J mg/kg  
Cadmium: 14 to 101 mg/kg                      Lead: 8270 to 13,100 mg/kg  
Chromium: 86J mg/kg                              Antimony: 33J mg/kg  
Copper: 159J to 308J mg/kg                      Zinc: 1,220J to 2,230J mg/kg
- There were three discharging adits identified at this site, the most significant of which was characterized by sample GW-1. GW-1 had a measured discharge of 0.6 cfs, a pH of 4.29, and a specific conductance of 270 umhos/cm. The MCL/MCLGs for arsenic and cadmium were exceeded. Acute aquatic life criteria were exceeded for arsenic, cadmium, copper, lead, and zinc. Chronic aquatic life criteria were exceeded for arsenic, cadmium, copper, iron, lead, mercury, and zinc. There was one significant seep associated with this site which was sampled as GW-2. This seep was discharging from the toe of WR-2 at an estimated flow of 35 gpm, a pH of 2.93 and a specific conductance of 1380 umhos/cm. The MCL/MCLGs for arsenic, cadmium, and antimony were exceeded. Acute aquatic life criteria were exceeded for arsenic, cadmium, copper, and zinc. Chronic aquatic life criteria were exceeded for arsenic, iron, copper, lead, and zinc.
- Indian Creek and a small perennial tributary into the creek were identified to be associated with this site. Observed releases were documented for arsenic, cadmium, lead, and zinc, which were directly attributable to this site. MCL/MCLGs were exceeded for arsenic and cadmium, which were directly attributable to the site. Acute aquatic life criteria were exceeded for cadmium, copper, and zinc. Chronic aquatic life criteria were exceeded for cadmium, copper, lead, mercury, and zinc.



**Park PA# 04-012**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/27/93**

| SOLID MATRIX ANALYSES |                |                                |                          |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
|-----------------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|------------|------------|------------|------------|-----------------|
| Metals in soils       |                | Results per dry weight basis   |                          |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
| FIELD ID              | As (mg/Kg)     | Ba (mg/Kg)                     | Cd (mg/Kg)               | Co (mg/Kg)                       | Cr (mg/Kg)       | Cu (mg/Kg)       | Fe (mg/Kg)       | Hg (mg/Kg)                       | Mn (mg/Kg)                       | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 04-012-SE-1           | 4350 J         | 84.7                           | 25                       | 17.7 J                           | 13 J             | 56.9 J           | 30600            | 0.144 J                          | 1690 J                           | 7 J        | 1850       | 9 UJ       | 2090 J     | NR              |
| 04-012-SE-2           | 11 J           | 112                            | 0.5 U                    | 8.2 J                            | 11 J             | 11.4 J           | 14500            | 0.064 J                          | 399 J                            | 8 J        | 11         | 6 UJ       | 46 J       | NR              |
| 04-012-TP-1           | 1260 J         | 66                             | 1                        | 2.1 J                            | 3 J              | 48.9 J           | 35500            | 0.056 J                          | 143 J                            | 3 UJ       | 4160       | 7 J        | 190 J      | 0.292 U         |
| 04-012-WR-1           | 4730 J         | 59.9                           | 14                       | 7.9 J                            | 6 J              | 159 J            | 65700            | 0.59 J                           | 790 J                            | 2 UJ       | 8270       | 19 J       | 1430 J     | NR              |
| 04-012-WR-2           | 8900 J         | 50.4                           | 18                       | 6.6 J                            | 7 J              | 202 J            | 58900            | 0.713 J                          | 781 J                            | 2 UJ       | 12800      | 27 J       | 1220 J     | NR              |
| 04-012-WR-3           | 9820 J         | 30.1                           | 101                      | 16 J                             | 86 J             | 308 J            | 71200            | 0.137 J                          | 702 J                            | 2 J        | 13100      | 33 J       | 2320 J     | NR              |
| BACKGROUND            | 44 J           | 315                            | 1 U                      | 24 J                             | 15 J             | 28.9 J           | 37600            | 0.088 J                          | 1220 J                           | 9 J        | 31         | 11 UJ      | 112 J      | NR              |
| Acid/Base Accounting  |                |                                |                          |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
| FIELD ID              | TOTAL SULFUR % | TOTAL SULFUR ACID BASE 1/1000t | NEUTRAL. POTENT. 1/1000t | SULFUR ACID BASE POTENT. 1/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE 1/1000t | SULFUR ACID BASE POTENT. 1/1000t |            |            |            |            |                 |
| 04-012-TP-1           | 2.00           | 62.5                           | -0.00                    | -62.5                            | 1.97             | <0.01            | 0.03             | 0.00                             | -0.00                            |            |            |            |            |                 |
| 04-012-WR-1           | 4.02           | 126                            | 20.6                     | -105                             | 0.37             | 2.00             | 1.65             | 62.5                             | -41.8                            |            |            |            |            |                 |
| 04-012-WR-2           | 1.25           | 39.0                           | -0.62                    | -39.7                            | 0.82             | 0.10             | 0.33             | 3.12                             | -3.74                            |            |            |            |            |                 |
| 04-012-WR-3           | 0.20           | 6.25                           | 2.58                     | -3.67                            | 0.13             | 0.02             | 0.05             | 0.62                             | 1.96                             |            |            |            |            |                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

| WATER MATRIX ANALYSES   |                        |                 |         |           |         |        |        |       |         |        |        |        |                 |                |
|---|------------------------|-----------------|---------|-----------|---------|--------|--------|-------|---------|--------|--------|--------|-----------------|----------------|
| Metals in Water   |                        | Results in ug/L |         |           |         |        |        |       |         |        |        |        |                 |                |
| FIELD ID  | As                     | Ba              | Cd      | Co        | Cr      | Cu     | Fe     | Hg    | Mn      | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
| 04-012-GW-1   | 548                    | 2.01 U          | 44.7    | 9.7 U     | 6.83 U  | 64.2   | 3450   | 0.16  | 842 J   | 12.7 U | 104    | 30.7 U | 5710            | 81             |
| 04-012-GW-2   | 3380                   | 7.6             | 563     | 134       | 6.83 U  | 975    | 32600  | 0.083 | 19900 J | 36.8   | 252    | 93.7   | 73600           | 374            |
| 04-012-SW-1   | 71                     | 15              | 11      | 9.7 U     | 6.83 U  | 15.6   | 902    | 0.055 | 324 J   | 12.7 U | 19.4   | 30.7 U | 1540            | 38.7           |
| 04-012-SW-2   | 1.69 U                 | 30.3            | 2.57 U  | 9.7 U     | 6.83 U  | 7.43 J | 308 J  | 0.093 | 14.5    | 13.2   | 1.55 U | 30.7 U | 46.1 JX         | 21             |
| 04-012-SW-3   | 215                    | 10.8            | 30.6    | 9.7 U     | 6.83 U  | 42.1 J | 1700 J | 0.11  | 495     | 12.7 U | 31.2   | 30.7 U | 3620 JX         | 62.4           |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                        |                 |         |           |         |        |        |       |         |        |        |        |                 |                |
| Wet Chemistry   |                        | Results in mg/l |         |           |         |        |        |       |         |        |        |        |                 |                |
| FIELD ID.   | TOTAL DISSOLVED SOLIDS | CHLORIDE        | SULFATE | NO3/NO2-N | CYANIDE |        |        |       |         |        |        |        |                 |                |
| 04-012-GW-1   | 203                    | < 5.0           | 104     | 0.39      | NR      |        |        |       |         |        |        |        |                 |                |
| 04-012-GW-2   | 1270                   | < 5.0           | 800     | 0.31      | <0.005  |        |        |       |         |        |        |        |                 |                |
| 04-012-SW-1   | 121                    | < 5.0           | 30      | 0.08      | <0.005  |        |        |       |         |        |        |        |                 |                |
| 04-012-SW-2   | 105                    | < 5.0           | < 5     | < 0.05    | NR      |        |        |       |         |        |        |        |                 |                |
| 04-012-SW-3   | 167                    | < 5.0           | 76      | 0.19      | NR      |        |        |       |         |        |        |        |                 |                |

SE1 - Downgradient Indian Creek.  
SE2 - Upgradient Indian Creek.  
TP1 - Composite of subsamples TP1 and 2.  
WR1 - Composite of subsamples WR1A, 1B, 2A, 2B, and 2C.  
WR2 - Composite of subsamples WR3A, 4A, 4B, 4C, 5A, 6A, 6B, 7A, and 9A.  
WR3 - Sample of the WR8 subsample.  
BACKGROUND - From the Park Mine (04-012-SS-1).

GW1 - Adit discharge at waste rock dump 2.  
GW2 - Seep below mill.  
SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.  
SW3 - Eastern tributary prior to confluence.

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**LEGEND**

SE1 - Downgradient Indian Creek.  
 SE2 - Upgradient Indian Creek.  
 TP1 - Composite of subsamples TP1 and 2.  
 WR1 - Composite of subsamples WR1A, 1B, 2A, 2B, and 2C.  
 WR2 - Composite of subsamples WR3A, 4A, 4B, 4C, 5A, 6A, 6B, 7A, and 9A.  
 WR3 - Sample of the WR3 subsample.  
 BACKGROUND - From the Park Mine (04-012-SS-1).

GW1 - Adit discharge at waste rock dump 2.  
 GW2 - Seep below mill.  
 SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.  
 SW3 - Eastern tributary prior to confluence.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |   |
|--|---|
| Mine/Site Name: <u>St. Louis</u>   | County: <u>Broadwater</u>                         |
| Legal Description: T <u>7N</u> R <u>1W</u>   | Section(s): <u>NW 1/4, NW 1/4, Sec.26</u>         |
| Mining District: <u>Indian Creek</u>   | Mine Type: <u>Hardrock/Ag. Au. Pb</u>             |
| Latitude: <u>N 46° 20' 19"</u>   | Primary Drainage: <u>Indian Creek</u>             |
| Longitude: <u>W 111° 41' 55"</u>   | USGS Code: <u>10030101</u>                        |
| Land Status: <u>Private/Public</u>   | Secondary Drainage: <u>West Fork Indian Creek</u> |
| Quad: <u>Giant Hill</u>  | Date Investigated: <u>July 27, 1993</u>           |
| Inspectors: <u>Bullock, Clark/Pierson</u>  | P.A. # <u>04-013</u>                              |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |   |

- There were no mill tailings observed at this site during the investigation.
- The volume of leach pad material associated with this site was estimated to be approximately 1,300 cubic yards. The concentration of cyanide measured in a sample of the leach pad material was 5.27 mg/kg. The following elements were elevated at least three times background:  
Arsenic: 2,110J mg/kg      Lead: 1,110 mg/kg  
Cadmium: 9 mg/kg      Zinc: 1,180J mg/kg  
Copper: 202J mg/kg
- The volume of waste rock associated with this site was estimated to be approximately 17,000 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 4,840 mg/kg      Lead: 2,590 mg/kg  
Cadmium: 38 mg/kg      Zinc: 1,540J mg/kg  
Copper: 316J mg/kg
- No MCLs were exceeded in upstream or downstream surface water samples collected from West Fork Indian Creek; however, chronic aquatic life criteria were exceeded for mercury in both the upstream and downstream samples, and the chronic aquatic life criteria for lead was exceeded in the downstream sample.
- Observed releases to West Fork Indian Creek were documented for arsenic and lead. The chronic aquatic life criteria exceedance for lead was directly attributable to the site. Additionally, significant increases in lead and zinc concentrations (greater than three times) were observed in downstream sediment samples collected from West Fork Indian Creek (compared to upstream concentrations).
- Potentially hazardous structures that were observed at the site included a trench highwall (20 to 40 feet high) and three small unstable buildings.

**St. Louis PA# 04-013**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - Bullock**  
**INVESTIGATION DATE: 07/27/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 04-013-LP-1 | 2110 J        | 47.6          | 9             | 7.9 J         | 5 J           | 202 J         | 33900         | 0.184 J       | 307 J         | 5 J           | 1110          | 7 J           | 1180 J        | 5.27               |
| 04-013-SE-1 | 22            | 78.4          | 2.6           | 7.1           | 7             | 19.1          | 22100         | 0.035 J       | 277           | 3 J           | 318           | 6 UJ          | 368           | NR                 |
| 04-013-SE-2 | 11            | 34.2          | 0.9           | 11            | 5.9           | 7.2           | 18600         | 0.017 J       | 335           | 5 J           | 15            | 6 UJ          | 60            | NR                 |
| 04-013-WR-1 | 4840 J        | 81.6          | 38            | 9 J           | 4 J           | 316 J         | 37500         | 0.164 J       | 776 J         | 4 J           | 2590          | 7 J           | 1540 J        | NR                 |
| BACKGROUND  | 44 J          | 315           | 1 U           | 24 J          | 15 J          | 28.9 J        | 37600         | 0.088 J       | 1220 J        | 9 J           | 31            | 11 UJ         | 112 J         | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 04-013-LP-1 | 0.74              | 23.1                                 | 13.6                          | -9.52                                     | <0.01                  | 0.25                   | 0.56                   | 7.81                                      | 5.78                                      |
| 04-013-WR-1 | 0.35              | 10.9                                 | 8.29                          | -2.64                                     | 0.33                   | <0.01                  | 0.03                   | 0.00                                      | 8.29                                      |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba       | Cd     | Co    | Cr     | Cu     | Fe   | Hg    | Mn     | Ni     | Pb   | Sb     | Zn     | HARDNESS<br>CALC.<br>Zn (mg CaCO3/L) |
|-------------|--------|----------|--------|-------|--------|--------|------|-------|--------|--------|------|--------|--------|--------------------------------------|
| 04-013-SW-1 | 3      | < 16.6 U | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 666  | 0.044 | 18.3 J | 12.7 U | 13.1 | 30.7 U | 20.7 U | 74.7                                 |
| 04-013-SW-2 | 0.96 U | 7.67     | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 44.5 | 0.052 | 9.1 J  | 12.7 U | 1.86 | 30.7 U | 7.57 U | 71.3                                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED<br>SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|---------------------------|----------|---------|-----------|---------|
| 04-013-SW-1 | 150                       | < 5.0    | 13      | 0.13      | < 0.01  |
| 04-013-SW-2 | 151                       | < 5.0    | 10      | 0.47      | NR      |

**LEGEND**

LP1 - Composite LP1A and 1B (Leach Pad).  
 SE1 - Downgradient on West Fork Indian Creek.  
 SE2 - Upgradient on West Fork Indian Creek.  
 WR1 - Sample of the WR1 subsample.  
 BACKGROUND - From the Park Mine (04-012-S8-1).

SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Diamond Hill</u>                   | County: <u>Broadwater</u>                         |
| Legal Description: <u>T 7N R 1W</u>                   | Section(s): <u>SW 1/4, NW 1/4, Sec. 36</u>        |
| Mining District: <u>Indian Creek</u>                  | Mine Type: <u>Hardrock/Au</u>                     |
| Latitude: <u>N 46° 18' 48"</u>                        | Primary Drainage: <u>Indian Creek</u>             |
| Longitude: <u>W 111° 40' 38"</u>                      | USGS Code: <u>10030101</u>                        |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>West Fork Indian Creek</u> |
| Quad: <u>Giant Hill</u>                               | Date Investigated: <u>July 28, 1993</u>           |
| Inspectors: <u>Babits, Flammang, Lasher</u>           | P.A. # <u>04-020</u>                              |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were approximately 220 cubic yards of uncovered tailings on site. The following were elevated at least three times background:  
Copper: 181J mg/kg  
Mercury: 3.38J mg/kg
- There were 71,000 cubic yards of mostly uncovered waste rock on site. The following was elevated at least three times background:  
Mercury: 0.369J to 0.61J mg/kg
- There were no discharging adits on site. There was one monitoring well located on site; no MCLs/MCLGs were exceeded.
- Tailings were located adjacent to the West Fork of Indian Creek; however, no MCLs/MCLGs or acute or chronic aquatic life criteria were exceeded which were attributable to the site.
- An observed release to the West Fork of Indian Creek (sediment) was documented for mercury.
- There were numerous hazardous openings and pits located on site.



**Diamond Hill PA# 04-020**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/28/93**

| SOLID MATRIX ANALYSES   |                |                                |                        |                                 |                  |                  |                  |                                  |                                 |            |            |            |            |                 |
|---|----------------|--------------------------------|------------------------|---------------------------------|------------------|------------------|------------------|----------------------------------|---------------------------------|------------|------------|------------|------------|-----------------|
| Metals in soils   |                | Results per dry weight basis   |                        |                                 |                  |                  |                  |                                  |                                 |            |            |            |            |                 |
| FIELD ID  | As (mg/Kg)     | Ba (mg/Kg)                     | Cd (mg/Kg)             | Co (mg/Kg)                      | Cr (mg/Kg)       | Cu (mg/Kg)       | Fe (mg/Kg)       | Hg (mg/Kg)                       | Mn (mg/Kg)                      | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 04-020-SE-1   | 78 J           | 165                            | 2                      | 20.6 J                          | 12 J             | 107 J            | 39400            | 0.158 J                          | 419 J                           | 13 J       | 285        | 11 UJ      | 300 J      | 0.622 U         |
| 04-020-SE-2   | 20 J           | 75.8                           | 0.6 U                  | 9.4 J                           | 8 J              | 120 J            | 27000            | 0.526 J                          | 226 J                           | 3 J        | 36         | 9 J        | 49 J       | 0.335 U         |
| 04-020-TP-1   | 44 J           | 73                             | 1.3                    | 14.3 J                          | 3 J              | 181 J            | 51200            | 3.38 J                           | 366 J                           | 2 UJ       | 15         | 6 UJ       | 46 J       | 0.291 U         |
| 04-020-WR-1   | 23 J           | 56.8                           | 0.9                    | 5.8 J                           | 5 J              | 67.4 J           | 52400            | 0.61 J                           | 119 J                           | 17 J       | 14         | 7 UJ       | 7 J        | NR              |
| 04-020-WR-2   | 76 J           | 55.4                           | 0.5                    | 18.4 J                          | 3 J              | 88.7 J           | 39200            | 0.369 J                          | 526 J                           | 3 J        | 13         | 5 UJ       | 47 J       | NR              |
| BACKGROUND  | 44 J           | 315                            | 1 U                    | 24 J                            | 15 J             | 28.9 J           | 37600            | 0.088 J                          | 1220 J                          | 9 J        | 31         | 11 UJ      | 112 J      | NR              |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                |                                |                        |                                 |                  |                  |                  |                                  |                                 |            |            |            |            |                 |
| Acid/Base Accounting  |                |                                |                        |                                 |                  |                  |                  |                                  |                                 |            |            |            |            |                 |
| FIELD ID  | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT t/1000t | SULFUR ACID BASE POTENT t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT t/1000t |            |            |            |            |                 |
| 04-020-TP-1   | 1.29           | 40.3                           | 7.45                   | -32.9                           | 1.13             | 0.09             | 0.07             | 2.81                             | 4.64                            |            |            |            |            |                 |
| 04-020-WR-1   | 2.64           | 82.5                           | -1.86                  | -84.3                           | 2.52             | 0.02             | 0.10             | 0.62                             | -2.49                           |            |            |            |            |                 |
| 04-020-WR-2   | 0.97           | 30.3                           | 12.2                   | -18.1                           | 0.89             | 0.02             | 0.06             | 0.62                             | 11.6                            |            |            |            |            |                 |

| WATER MATRIX ANALYSES   |        |                 |        |       |        |        |       |       |        |        |        |        |                 |                |
|---|--------|-----------------|--------|-------|--------|--------|-------|-------|--------|--------|--------|--------|-----------------|----------------|
| Metals in Water   |        | Results in ug/L |        |       |        |        |       |       |        |        |        |        |                 |                |
| FIELD ID  | As     | Ba              | Cd     | Co    | Cr     | Cu     | Fe    | Hg    | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
| 04-020-GW-1   | 1.69 U | 22.3            | 2.57 U | 9.7 U | 6.83 U | 5.27 J | 23 J  | 0.072 | 4.08 U | 12.7 U | 1.55 U | 30.7 U | 23.5 JX         | 232            |
| 04-020-GW-2   | 3.03   | 22.4            | 2.57 U | 9.7 U | 6.83 U | 5.33 J | 23 J  | 0.1   | 4.08 U | 12.7 U | 1.55 U | 30.7 U | 17.7 JX         | 239            |
| 04-020-SW-1   | 4.62   | 20.8            | 2.57 U | 9.7 U | 6.83 U | 5.47 J | 310 J | 0.096 | 31.4   | 12.7 U | 6.36   | 30.7 U | 22.4 JX         | 96.8           |
| 04-020-SW-2   | 4.37   | 20.2            | 2.57 U | 9.7 U | 6.83 U | 5.1 J  | 211 J | 0.12  | 13.6   | 12.7 U | 3.73   | 30.7 U | 18.5 JX         | 103            |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |        |                 |        |       |        |        |       |       |        |        |        |        |                 |                |

| Wet Chemistry |                        | Results in mg/l |         |           |         |  |
|---------------|------------------------|-----------------|---------|-----------|---------|--|
| FIELD ID.     | TOTAL DISSOLVED SOLIDS | CHLORIDE        | SULFATE | NO3/NO2-N | CYANIDE |  |
| 04-020-GW-1   | 375                    | 6.7             | 98      | 0.82      | NR      |  |
| 04-020-GW-2   | 385                    | 7.2             | 99      | 0.79      | NR      |  |
| 04-020-SW-1   | 188                    | < 5.0           | 37      | 0.05      | < 0.01  |  |
| 04-020-SW-2   | 195                    | < 5.0           | 38      | < 0.05    | < 0.01  |  |

LEGEND

SE1 - Upgradient on West Fork Indian Creek.  
SE2 - Downgradient on West Fork Indian Creek.  
TP1 - Composite of subsamples TP1A-A, B, TP1B-A, and B.  
WR1 - Composite of subsamples WR1A, 1B, 1C, and 1D.  
WR2 - Composite of subsamples WR2, WR4, WR6, WR9, and WR11.  
BACKGROUND - From Park (Marietta) (04-012-SS1).

GW1 - Monitoring well at mouth of Engh Pit by adit 3.  
GW2 - Duplicate of GW1.  
SW1 - Same as SE1.  
SW2 - Same as SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Ohio  
Legal Description: T 5N R 1W  
Mining District: Radersburg  
Latitude: N 46° 11' 08"  
Longitude: W 111° 40' 07"  
Land Status: Private  
Quad: Radersburg  
Inspectors: Bullock, M. Babits, S. Babits,  
Flammang/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Broadwater  
Section(s): NW 1/4, SE 1/4, Sec. 13  
Mine Type: Hardrock/Au  
Primary Drainage: Crow Creek  
USGS Code: 10030101  
Secondary Drainage: Keating Gulch  
Date Investigated: September 3, 1993  
P.A. # 04-009

- The volume of tailings associated with this site was estimated to be 37,000 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 203J to 321J mg/kg      Iron: 79,600J mg/kg  
Cobalt: 32.2 to 86.3 mg/kg      Mercury: 0.35J to 0.595J mg/kg  
Copper: 142 to 350 mg/kg      Zinc: 207J to 333J mg/kg
- The volume of waste rock associated with this site was estimated to be 19,500 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 136J mg/kg      Iron: 75,400J mg/kg  
Cobalt: 29.4 mg/kg      Mercury: 0.622J mg/kg  
Copper: 98.4 mg/kg      Lead: 189J mg/kg
- There were no adit discharges, seeps or springs associated with this site.
- Keating Gulch flowed to the north of this site. No observed water releases were attributable to this site. No MCLs or MCLGs, or acute or chronic aquatic life criteria were exceeded. Sediment samples were collected up and down stream of this site. Observed releases of arsenic, copper, and iron were documented; directly attributed to this site.
- The shaft and adit on the north side of Keating Gulch were identified as hazard mine openings. In addition, the loadout and several of the cabins were classified as hazardous structures.

**Ohio PA# 04-009**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 09/03/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 04-009-SE-1 | 8.63 J        | 55.3 J        | 0.9 U         | 7.53          | 3.96          | 22.6          | 17700 J       | 0.059 J       | 355           | 7.59 J        | 30.2 J        | 6.12 UJ       | 148 J         | NR                 |
| 04-009-SE-2 | 50.6 J        | 56.4 J        | 0.8 U         | 12.5          | 4.9           | 75.9          | 35300 J       | 0.071 J       | 295           | 7.85 J        | 29.4 J        | 5.76 UJ       | 85.5 J        | NR                 |
| 04-009-TP-1 | 321 J         | 36.3 J        | 1.1 U         | 86.3          | 8.35          | 350           | 79600 J       | 0.595 J       | 269           | 8.45 J        | 70.9 J        | 7.44 UJ       | 333 J         | NR                 |
| 04-009-TP-2 | 203 J         | 54 J          | 1.0 U         | 32.2          | 7.41          | 142           | 46000 J       | 0.35 J        | 264           | 5.82 J        | 50.1 J        | 6.56 UJ       | 207 J         | NR                 |
| 04-009-WR-1 | 136 J         | 94.1 J        | 0.7 U         | 29.4          | 3.07          | 98.4          | 75400 J       | 0.622 J       | 27.7          | 1.89 J        | 189 J         | 5.13 UJ       | 36.1 J        | NR                 |
| BACKGROUND  | 6.11 J        | 214 J         | 1.0 U         | 8.92          | 6.14          | 22.6          | 19200 J       | 0.106 J       | 819           | 7.83 J        | 25.2 J        | 6.96 UJ       | 79.6 J        | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 04-009-TP-1 | 4.85              | 152                                  | 36.7                          | -115                                      | 3.11                   | 1.5                    | 0.24                   | 46.9                                      | -10.1                                     |
| 04-009-TP-2 | 3.44              | 107                                  | 39.9                          | -68                                       | 104                    | 2.28                   | 0.12                   | 71.2                                      | -31.3                                     |
| 04-009-WR-1 | 9.32              | 291                                  | -16                           | -307                                      | 4.3                    | 3.07                   | 1.95                   | 95.9                                      | -112                                      |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co  | Cr     | Cu     | Fe   | Hg     | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS<br>CALC. |
|-------------|--------|------|--------|-----|--------|--------|------|--------|--------|--------|--------|--------|-----------------|-------------------|
| 04-009-SW-1 | 1.18 U | 37.9 | 4.59 U | 5 U | 6.24 U | 2.33 U | 34.4 | 0.12 U | 5.4    | 10.9 U | 0.72 U | 31.7 U | 11.1            | 309               |
| 04-009-SW-2 | 1.18 U | 33.4 | 4.59 U | 5 U | 6.24 U | 2.33 U | 85.9 | 0.12 U | 3.76 U | 10.9 U | 0.93   | 31.7 U | 9.33            | 281               |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED<br>SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|---------------------------|----------|---------|-----------|---------|
| 04-009-SW-1 | 390                       | 7.0      | 131     | < 0.05    | NR      |
| 04-009-SW-2 | 366                       | 8.0      | 135     | < 0.05    | NR      |

**LEGEND**

SE1 - 540 feet upgradient of mill building in Keating Gulch.

SE2 - 400 feet downgradient in Keating Gulch.

TP1 - Composite of subsamples TP1A-A, 2A-B, 2A-C, 2A-D, 2B-A, 2B-B, and 2B-C.

TP2 - Composite of subsamples TP2A-A, 2A-B, 2A-C, 2A-D, 2B-A, 2B-B, and 2B-C.

WR1 - Composite of subsamples WR1A through 1C, 2A, and 2B.

BACKGROUND - 850 feet upgradient from mill building.  
From the Ohio Mine (04-009-SS-1).

SW1 - Same as sample SE1.

SW2 - Same as sample SE2.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |   |
|--|---|
| Mine/Site Name: <u>Keating Tailings</u>          | County: <u>Broadwater</u>                   |
| Legal Description: <u>T 5N R 1E</u>              | Section(s): <u>SE 1/4, SE 1/4, Sec. 18</u>  |
| Mining District: <u>Radersburg</u>               | Mine Type: <u>Hardrock/Au, Cu</u>           |
| Latitude: <u>N 46° 11' 02"</u>                   | Primary Drainage: <u>Crow Creek</u>         |
| Longitude: <u>W 111° 39' 34"</u>                 | USGS Code: <u>10030101</u>                  |
| Land Status: <u>Private/Public</u>               | Secondary Drainage: <u>Keating Gulch</u>    |
| Quad: <u>Radersburg</u>                          | Date Investigated: <u>September 3, 1993</u> |
| Inspectors: <u>M. Babits. S. Babits.</u>         | P.A. # <u>04-121</u>                        |
| <u>Flammang/Pierson</u>                          |   |
| Organization: <u>Pioneer Technical Services,</u> |   |
| <u>Inc./Thomas, Dean and Hoskins, Inc.</u>       |   |

- The volume of tailings associated with this site was estimated to be 144,000 cubic yards. The following elements were elevated at least three times background:

|                                |                           |
|--------------------------------|---------------------------|
| Arsenic: 143J to 336J mg/kg    | Manganese: 3040 mg/kg     |
| Copper: 378 to 486 mg/kg       | Lead: 684J mg/kg          |
| Iron: 43,200J to 55,200J mg/kg | Zinc: 251J to 2640J mg/kg |
| Mercury: 0.76J mg/kg           |                           |
- Waste rock associated with this site was located in an active mining area and was not investigated.
- There were no discharges associated with mine openings identified at this site. There was a spring located near the northeast corner of the toe of TP-2, which was characterized by sample SW-1. The flow of the spring was measured at 0.04 cfs with a pH of 6.6 and specific conductance of 470 umhos/cm. No MCLs or MCLGs were exceeded. In addition, no acute or chronic aquatic life criteria were exceeded.
- Keating Gulch, and intermittent stream, was dry at the time of this investigation. The stream channel had been diverted around the tailings impoundment. Sediment samples were collected in the dry gulch up gradient and down gradient from this site. No observed releases could be attributed to this site.
- Precipitation was ponded on the lower tailings pond.



**Keating Tailings PA# 04-121**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 09/03/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 04-121-SE-1 | 26.7 J     | 50 J       | 0.7 U      | 13.1       | 6.48       | 52.5       | 21500 J    | 0.026 U    | 455        | 8.18 J     | 40.6 J     | 5.09 UJ    | 108 J      | NR              |
| 04-009-SE-2 | 50.6 J     | 56.4 J     | 0.8 U      | 12.5       | 4.9        | 75.9       | 35300 J    | 0.071 J    | 295        | 7.85 J     | 29.4 J     | 5.76 UJ    | 85.5 J     | NR              |
| 04-121-TP-1 | 143 J      | 128 J      | 0.9 U      | 9.52       | 11.6       | 378        | 43200 J    | 0.184 J    | 235        | 5.23 J     | 57.3 J     | 5.91 UJ    | 251 J      | NR              |
| 04-121-TP-2 | 336 J      | 279 J      | 1.7        | 11.2       | 8.17       | 486        | 55200 J    | 0.76 J     | 3040       | 11.1 J     | 684 J      | 7.74 UJ    | 2640 J     | NR              |
| BACKGROUND  | 6.11 J     | 214 J      | 1.0 U      | 8.92       | 6.14       | 22.6       | 19200 J    | 0.106 J    | 819        | 7.83 J     | 25.2 J     | 6.96 UJ    | 79.6 J     | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 04-121-TP-1 | 1.81           | 56.5                           | -2                       | -59                              | 1.29             | 0.5              | 0.02             | 15.6                             | -17.7                            |
| 04-121-TP-1 | 1.8            | 56.2                           | -1.9                     | -58                              | 1.28             | 0.44             | 0.08             | 13.7                             | -15.7                            |
| 04-121-TP-2 | 0.93           | 29.1                           | 7.93                     | -21                              | 0.85             | 0.03             | 0.05             | 0.94                             | 6.99                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co  | Cr     | Cu     | Fe   | Hg     | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. (mg CaCO3/L) |
|-------------|--------|------|--------|-----|--------|--------|------|--------|--------|--------|--------|--------|-----------------|-----------------------------|
| 04-121-SW-1 | 3.85   | 8.6  | 4.59 U | 5 U | 9.37 U | 2.33 U | 894  | 0.12 U | 707    | 10.9 U | 0.72 U | 31.7 U | 13.6            | 1050                        |
| 04-009-SW-2 | 1.18 U | 33.4 | 4.59 U | 5 U | 6.24 U | 2.33 U | 85.9 | 0.12 U | 3.76 U | 10.9 U | 0.93   | 31.7 U | 9.33            | 281                         |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD I.D.  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 04-121-SW-1 | 1604                   | 18       | 981     | < 0.05    | < 0.005 |
| 04-009-SW-2 | 366                    | 8.0      | 135     | < 0.05    | NR      |

**LEGEND**

SE1 - Downgradient in Keating Gulch.  
SE2 - 400' downgradient of berm on tailing pond 2 of the Ohio Mine. This serves as the upgradient sample for 04-121.  
TP1 - Composite of subsamples TP1A-A, B, C, and 1B-A, B, C.  
TP2 - Composite of subsamples TP2A-A, B, C, and 2B-A, B.  
BACKGROUND - From the Ohio Mine (04-009-SS-1).  
TP1DUP - Duplicate of the sample 04-121-TP1.

SW1 - Spring at the toe of tailings pond 2.  
SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>East Pacific</u>                   | County: <u>Broadwater</u>                      |
| Legal Description: T <u>8N</u> R <u>1W</u>            | Section(s): <u>Sec. 26 and Sec. 27</u>         |
| Mining District: <u>Winston</u>                       | Mine Type: <u>Hardrock/Au, Ag, Pb, Zn, Cu</u>  |
| Latitude: <u>N 46° 25.1'</u>                          | Primary Drainage: <u>Weasel Creek</u>          |
| Longitude: <u>W 111° 42.2'</u>                        | USGS Code: <u>10030101</u>                     |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Spring Gulch</u>        |
| Quad: <u>Winston</u>                                  | Date Investigated: <u>July 27 and 28, 1993</u> |
| Inspectors: <u>Babits, Flammang, Lasher</u>           | P.A. # <u>04-008</u>                           |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were approximately 1,450 cubic yards of uncovered tailings on site. The following were elevated at least three times background:

|                       |                         |
|-----------------------|-------------------------|
| Arsenic: 458J mg/kg   | Cadmium: 32 mg/kg       |
| Cobalt: 11.5J mg/kg   | Chromium: 35J mg/kg     |
| Copper: 399J mg/kg    | Iron: 31,600 mg/kg      |
| Mercury: 0.256J mg/kg | Manganese: 2,510J mg/kg |
| Nickel: 33J mg/kg     | Lead: 4,760 mg/kg       |
| Antimony 33J mg/kg    | Zinc: 5,550 J mg/kg     |
  
- There were approximately 74,900 cubic yards of mostly uncovered waste rock on site. The following were elevated at least three times background:

|                                 |                                  |
|---------------------------------|----------------------------------|
| Arsenic: 575J mg/kg             | Cadmium: 36 to 53 mg/kg          |
| Cobalt: 11.4J to 20.2J mg/kg    | Chromium: 11J to 95J mg/kg       |
| Copper: 213J to 980J mg/kg      | Iron: 32,700 to 42,100 mg/kg,    |
| Mercury: 0.325J to 0.789J mg/kg | Manganese: 1,620 to 1,710J mg/kg |
| Nickel: 13J to 101J mg/kg       | Lead: 4,000 to 6,160 mg/kg       |
| Antimony: 18J to 116J mg/kg     | Zinc: 4,650J to 8,240J mg/kg     |
  
- There were two discharging adits identified at the site. The adit associated with WR-4 was sampled (SW-3); the pH measurement was 8.02. The discharge did not enter the creek via a surface route. The MCL/ MCLG for cadmium and acute and chronic aquatic life criteria for zinc were exceeded in the adit discharge. Additionally, the chronic aquatic life criteria for mercury was exceeded in the adit discharge.
  
- There were tailings in Spring Creek. Observed releases to Spring Creek were documented for arsenic, cadmium, iron, manganese, lead, and zinc. The MCL for cadmium was exceeded in the downstream sample, and acute and chronic aquatic life criteria were exceeded for cadmium and zinc in the downstream sample. These exceedances were directly attributable to the site.

**East Pacific PA# 04-008**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/27/93**

| SOLID MATRIX ANALYSES   |                |                                |                          |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
|---|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|------------|------------|------------|------------|-----------------|
| Metals in soils   |                | Results per dry weight basis   |                          |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
| FIELD ID  | As (mg/Kg)     | Ba (mg/Kg)                     | Cd (mg/Kg)               | Co (mg/Kg)                       | Cr (mg/Kg)       | Cu (mg/Kg)       | Fe (mg/Kg)       | Hg (mg/Kg)                       | Mn (mg/Kg)                       | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 04-008-SE-1   | 30 J           | 124                            | 1.1 U                    | 13.5 J                           | 36 J             | 88.3 J           | 27400            | 0.173 J                          | 763 J                            | 24 J       | 49         | 13 UJ      | 133 J      | 0.58 U          |
| 04-008-SE-2   | 365 J          | 73.3                           | 31                       | 13.6 J                           | 40 J             | 347 J            | 27200            | 0.227 J                          | 2350 J                           | 32 J       | 2690       | 42 J       | 6120 J     | 0.298 U         |
| 04-008-TP-1   | 458 J          | 64.2                           | 32                       | 11.5 J                           | 35 J             | 399 J            | 31600            | 0.256 J                          | 2510 J                           | 33 J       | 4760       | 33 J       | 5550 J     | 0.283 U         |
| 04-008-WR-1   | 575 J          | 107                            | 48                       | 20.2 J                           | 95 J             | 980 J            | 42100            | 0.608 J                          | 1620 J                           | 101 J      | 6160       | 116 J      | 8240 J     | NR              |
| 04-008-WR-2   | 236 J          | 56.9                           | 53                       | 13.5 J                           | 33 J             | 475 J            | 38600            | 0.789 J                          | 1710 J                           | 28 J       | 4250       | 34 J       | 6950 J     | NR              |
| 04-008-WR-3   | 214 J          | 65.3                           | 36                       | 11.4 J                           | 11 J             | 213 J            | 32700            | 0.325 J                          | 1680 J                           | 13 J       | 4000       | 18 J       | 4650 J     | NR              |
| BACKGROUND  | 85             | 63.2                           | 0.7                      | 1.9 U                            | 1.9              | 11.6             | 9000             | 0.011 J                          | 470                              | 3 U        | 77         | 6 UJ       | 74         | NR              |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                |                                |                          |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
| Acid/Base Accounting  |                |                                |                          |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
| FIELD ID  | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |            |            |            |            |                 |
| 04-008-TP1-DUP  | 0.86           | 26.9                           | 73.3                     | 46.5                             | <0.01            | 0.56             | 0.34             | 17.5                             | 55.8                             |            |            |            |            |                 |
| 04-008-TP-1   | 0.88           | 27.5                           | 73.3                     | 45.8                             | <0.01            | 0.53             | 0.35             | 16.6                             | 56.8                             |            |            |            |            |                 |
| 04-008-WR-1   | 0.58           | 18.1                           | 22.3                     | 4.16                             | 0.22             | 0.05             | 0.31             | 1.56                             | 20.7                             |            |            |            |            |                 |
| 04-008-WR-2   | 3.42           | 107                            | 93.0                     | -13.9                            | 0.60             | 1.22             | 1.60             | 38.1                             | 54.9                             |            |            |            |            |                 |
| 04-008-WR-3   | 3.00           | 93.7                           | 86.7                     | -7.02                            | 0.42             | 1.43             | 1.15             | 44.7                             | 42.0                             |            |            |            |            |                 |

| WATER MATRIX ANALYSES |        |                 |        |       |        |        |        |      |        |        |        |        |                                      |      |
|-----------------------|--------|-----------------|--------|-------|--------|--------|--------|------|--------|--------|--------|--------|--------------------------------------|------|
| Metals in Water       |        | Results in ug/L |        |       |        |        |        |      |        |        |        |        |                                      |      |
| FIELD ID              | As     | Ba              | Cd     | Co    | Cr     | Cu     | Fe     | Hg   | Mn     | Ni     | Pb     | Sb     | HARDNESS<br>CALC.<br>Zn (mg CaCO3/L) |      |
| 04-008-SW-1           | 1.69 U | 3.9             | 2.57 U | 9.7 U | 6.83 U | 3.6 J  | 25.3 J | 0.12 | 4.08 U | 12.7 U | 1.55 U | 30.7 U | 7.57 U                               | 30.5 |
| 04-008-SW-2           | 9.59   | 10.9            | 12.8   | 9.7 U | 6.83 U | 10.7 J | 191 J  | 0.11 | 33.9   | 12.7 U | 72.6   | 30.7 U | 939 JX                               | 102  |
| 04-008-SW-3           | 6.35   | 4.6             | 8.9    | 9.7 U | 6.83 U | 4.9 J  | 16.1 J | 0.12 | 5.57   | 12.7 U | 2.88   | 30.7 U | 774 JX                               | 196  |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

| Wet Chemistry |                        | Results in mg/l |         |           |         |  |
|---------------|------------------------|-----------------|---------|-----------|---------|--|
| FIELD ID.     | TOTAL DISSOLVED SOLIDS | CHLORIDE        | SULFATE | NO3/NO2-N | CYANIDE |  |
| 04-008-SW-1   | 97                     | < 5.0           | 12      | 0.1       | < 0.01  |  |
| 04-008-SW-2   | 201                    | < 5.0           | 72      | 0.21      | < 0.01  |  |
| 04-008-SW-3   | 320                    | < 5.0           | 139     | 0.4       | NR      |  |

**LEGEND**

SE1 - 100 feet upgradient of waste rock dump 3 in Spring Creek.  
SE2 - 100 feet downgradient of tailings in Spring Creek.  
TP1 - Composite of subsamples TP-1A-A, B, C, TP1B-B, and A.  
WR1 - Composite of subsamples WR1A, B, C, WR2A, B, and C.  
WR2 - Composite of subsamples WR3A and 3B.  
WR3 - Composite of subsamples WR4A, B, WR5A, B, and C.  
BACKGROUND - From Vosburg (04-014-SS1).  
TP1-DUP - Duplicate of 04-008-TP-1.

SW1 - Same as SE1.  
SW2 - Same as SE2.  
SW3 - Adit discharge at waste rock dump 4.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Vosburg</u>                        | County: <u>Broadwater</u>                  |
| Legal Description: T <u>8N</u> R <u>1W</u>            | Section(s): <u>SW 1/4, SW 1/4, Sec. 34</u> |
| Mining District: <u>Winston</u>                       | Mine Type: <u>Hardrock/Au, Pb, Ag, Zn</u>  |
| Latitude: <u>N 46° 23' 58"</u>                        | Primary Drainage: <u>Beaver Creek</u>      |
| Longitude: <u>W 111° 43' 11"</u>                      | USGS Code: <u>10030101</u>                 |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Badger Creek</u>    |
| Quad: <u>Winston</u>                                  | Date Investigated: <u>July 27, 1993</u>    |
| Inspectors: <u>Babits, Lasher, Flammang</u>           | P.A. # <u>04-014</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were approximately 2,200 cubic yards of tailings at the site. The majority of the tailings were uncovered. The following were elevated three times background:

|                       |                        |
|-----------------------|------------------------|
| Arsenic: 13,100 mg/kg | Cadmium: 7.8 mg/kg     |
| Cobalt: 6.2 mg/kg     | Chromium: 16.6 mg/kg   |
| Copper: 780 mg/kg     | Iron: 78,600 mg/kg     |
| Mercury: 0.256J mg/kg | Manganese: 2,080 mg/kg |
| Lead: 4,640 mg/kg     | Antimony: 12 mg/kg     |
| Zinc: 564 mg/kg       | Cyanide: 8.38 mg/kg    |
- There were approximately 29,850 cubic yards of uncovered waste rock on site. The following were elevated at least three times background:

|                                 |                               |
|---------------------------------|-------------------------------|
| Arsenic: 204 to 3,990 mg/kg     | Cadmium: 5.9 to 8.4 mg/kg     |
| Cobalt: 7.9 mg/kg               | Copper: 38.2 to 379 mg/kg     |
| Iron: 30,500 to 32,800 mg/kg    | Mercury: 1.41J to 1.64J mg/kg |
| Manganese: 2,030 to 3,860 mg/kg | Lead: 729 to 737 mg/kg        |
| Zinc: 318 to 596 mg/kg          |                               |
- Neither of the two discharging adits had a surface route to water. A sample was collected from the discharge associated with WR-5 (SW-5). The MCL for arsenic and the chronic aquatic life criteria for arsenic, mercury, and lead were exceeded in the adit discharge.
- There were tailings in Badger Creek. Observed releases to Badger Creek were documented for arsenic, copper, iron, manganese, lead, and zinc. The MCL for arsenic was exceeded in downstream sample, as were the acute and chronic aquatic life criteria for copper and lead. Additionally, the chronic aquatic life criteria for iron was exceeded in the downstream sample. These exceedances were directly attributable to the site.



**Vosburg PA# 04-014**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/27/93**

| SOLID MATRIX ANALYSES |            |                              |            |            |            |            |            |            |            |            |            |            |            |                 |
|-----------------------|------------|------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| Metals in soils       |            | Results per dry weight basis |            |            |            |            |            |            |            |            |            |            |            |                 |
| FIELD ID              | As (mg/Kg) | Ba (mg/Kg)                   | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 04-014-SE-1           | 60         | 65.3                         | 1.3        | 3.7        | 7.4        | 17.5       | 10400      | 0.038 J    | 392        | 5 J        | 47         | 8 UJ       | 87         | 0.436 U         |
| 04-014-SE-2           | 8860       | 76.8                         | 5.4        | 3.4        | 10.3       | 564        | 54400      | 0.102 J    | 1600       | 3 U        | 3590       | 13 J       | 332        | 1.1             |
| 04-014-TP-1           | 13100      | 95                           | 7.8        | 6.2        | 16.6       | 780        | 78600      | 0.256 J    | 2080       | 4 J        | 4640       | 12 J       | 564        | 8.38            |
| 04-014-WR-1           | 2030       | 131                          | 8.4        | 7.9        | 1.5        | 273        | 30500      | 1.64 J     | 3860       | 3 U        | 737        | 6 UJ       | 596        | NR              |
| 04-014-WR-2           | 204        | 33.1                         | 0.6        | 2.4        | 1.3 U      | 38.2       | 8670       | 1.41 J     | 598        | 2 U        | 86         | 6 UJ       | 63         | NR              |
| 04-014-WR-3           | 3990       | 175                          | 5.9        | 5.6        | 1.3 U      | 379        | 32800      | 1.56 J     | 2030       | 2 U        | 729        | 6 UJ       | 318        | NR              |
| BACKGROUND            | 85         | 63.2                         | 0.7        | 1.9 U      | 1.9        | 11.6       | 9000       | 0.011 J    | 470        | 3 U        | 77         | 6 UJ       | 74         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

| Acid/Base Accounting |                |                                |                          |                                  |                  |                  |                  |                                  |                                  |
|----------------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| FIELD ID             | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
| 04-014-TP-1          | 0.35           | 10.9                           | 15.8                     | 4.89                             | 0.33             | <0.01            | 0.02             | 0.00                             | 15.8                             |
| 04-014-WR-1          | 0.04           | 1.25                           | 6.97                     | 5.72                             | 0.03             | <0.01            | 0.01             | 0.00                             | 6.97                             |
| 04-014-WR-2          | 0.04           | 1.25                           | 12.8                     | 11.6                             | 0.01             | <0.01            | 0.03             | 0.00                             | 12.8                             |
| 04-014-WR-3          | 0.65           | 20.3                           | 6.38                     | -13.9                            | 0.41             | 0.09             | 0.15             | 2.81                             | 3.57                             |

| WATER MATRIX ANALYSES   |                 |        |                 |       |        |        |      |         |        |        |      |        |                 |          |
|---|-----------------|--------|-----------------|-------|--------|--------|------|---------|--------|--------|------|--------|-----------------|----------|
| FIELD ID  | Metals in Water |        | Results in ug/L |       |        |        |      |         |        |        |      |        |                 | HARDNESS |
|   | As              | Ba     | Cd              | Co    | Cr     | Cu     | Fe   | Hg      | Mn     | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | CALC.    |
| 04-014-SW-1   | 2.67            | 2.01 U | 2.57 U          | 9.7 U | 6.83 U | 1.55 U | 123  | 0.038 U | 4.08 U | 12.7 U | 4.64 | 30.7 U | 7.57 U          | 21.5     |
| 04-014-SW-2   | 295             | 4.67   | 2.57 U          | 9.7 U | 6.83 U | 14.9   | 1300 | 0.038   | 61.6 J | 12.7 U | 35.3 | 30.7 U | 27.1            | 25.5     |
| 04-014-SW-5   | 268             | 2.01 U | 2.57 U          | 9.7 U | 6.83 U | 1.55 U | 409  | 0.087   | 5.5 J  | 12.7 U | 2.95 | 30.7 U | 7.57 U          | 43       |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                 |        |                 |       |        |        |      |         |        |        |      |        |                 |          |

| Wet Chemistry |                        | Results in mg/l |         |           |         |  |
|---------------|------------------------|-----------------|---------|-----------|---------|--|
| FIELD I.D.    | TOTAL DISSOLVED SOLIDS | CHLORIDE        | SULFATE | NO3/NO2-N | CYANIDE |  |
| 04-014-SW-1   | 108                    | < 5.0           | 6       | < 0.05    | < 0.01  |  |
| 04-014-SW-2   | 127                    | < 5.0           | 8       | < 0.05    | < 0.01  |  |
| 04-014-SW-5   | 122                    | < 5.0           | 12      | 1.3       | NR      |  |

| LEGEND   |  |
|--|--|
| SE1 - 100 feet upgradient of tailings in Badger Creek.       | SW1 - Same as SE1.                         |
| SE2 - At PPE of adit discharge and tailings in Badger Creek. | SW2 - Same as SE2.                         |
| TP1 - Composite of subsamples TP1A, 1B, and TP2A-A.          | SW5 - Adit discharge of waste rock dump 5. |
| WR1 - Composite of subsamples WR1, 2A, and 2B.               |  |
| WR2 - Composite of subsamples WR3A and B.                    |  |
| WR3 - Composite of subsamples WR4A, 4B, 5A, 5B, 5C, and 5D.  |  |
| BACKGROUND - From Vosburg (04-014-S81).                      |  |

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Block "P" Tailings  
Legal Description: T 15N R 8E  
Mining District: Barker/Hughesville  
Latitude: 47° 03' 20"  
Longitude: 110° 38' 56"  
Land Status: Private/Public  
Quad: Barker  
Inspectors: Bullock, Babits, Flammang,  
Lasher, Clark / Pierson  
Organization: Pioneer Technical Services,  
Inc./ Thomas, Dean and Hoskins, Inc.

County: Cascade  
Section(s): SE 1/4, Sec. 16  
Mine Type: Mill Tailings  
Primary Drainage: Dry Fork Belt Creek  
USGS Code: 10030105  
Secondary Drainage: Galena Creek  
Date Investigated: June 7, 1993  
P.A. # 07-090

- The total volume of mill tailings associated with this site was estimated at 625,000 cubic yards, contained in two impoundments (upper and lower). The following elements were elevated at least three times background in previous investigations:

|                             |                               |
|-----------------------------|-------------------------------|
| Arsenic: 520 to 2,140 mg/kg | Cadmium: 13.0 to 68.0 mg/kg   |
| Copper: 254 to 688 mg/kg    | Iron: 44,200 to 141,000 mg/kg |
| Mercury: 0.35 to 1.00 mg/kg | Lead: 4,000 to 10,600 mg/kg   |
- The tailings were poorly contained, and were actively eroding into Galena Creek. The tailings had a very low pH (1.81), were unvegetated, and had large erosion channels cut through them. An additional 10,000 cubic yards of tailing materials were observed in large stream side deposits downstream in Dry Fork Belt Creek.
- No waste rock or flowing adits were associated with this site.
- Surface water samples were collected during the 1993 investigation. Observed releases to surface water were documented for Arsenic in water, and mercury in sediment samples. Drinking water standards (MCL's) were exceeded for arsenic, cadmium, lead, and antimony; acute aquatic life criteria exceedances for cadmium, copper, and zinc were also documented. Upstream samples exceeded MCL's for cadmium, antimony, and lead, and acute aquatic life criteria for cadmium, copper, and zinc; the Hughesville mining district was upstream from the site and contributed to the observed upstream water quality degradation.
- Monitoring wells, sampled previously, indicated that MCL's were exceeded for cadmium, copper, nickel, and lead. These samples also documented an observed release to groundwater for cadmium, copper, iron, and lead. manganese, zinc, and nickel concentrations were very elevated in the downgradient well.
- No hazardous structures or openings were observed at the site.

**Block P. Tailings PA# 07-090**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/07/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 07-090-SE-1 | 396           | 486           | 9.4 J         | 7.7 J         | 8.5           | 182 J         | 51700         | 0.147 J       | 3120 J        | 25 J          | 705           | 5 U           | 1590 J        | NR                 |
| 07-090-SE-2 | 140           | 97.3          | 13.2 J        | 7 J           | 3.9           | 149 J         | 21600         | 0.037 J       | 2720 J        | 18 J          | 1070          | 3 U           | 2080 J        | 0.31 U             |
| 07-090-SE-3 | 196           | 123           | 11.1 J        | 7.6 J         | 2.8           | 149 J         | 26700         | 0.045 J       | 4030 J        | 23 J          | 1110          | 4 U           | 1970 J        | 0.57               |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd   | Co     | Cr  | Cu   | Fe   | Hg      | Mn   | Ni     | Pb   | Sb   | HARDNESS<br>CALC.<br>Zn (mg CaCO3/L) |
|-------------|------|------|------|--------|-----|------|------|---------|------|--------|------|------|--------------------------------------|
| 07-090-SW-1 | 9.92 | 40.7 | 2.9  | 5.99 U | 5 U | 23.5 | 1390 | 0.038 U | 790  | 8.78 U | 6.75 | 36.9 | 632                                  |
| 07-090-SW-2 | 54.5 | 45.4 | 16.3 | 5.99 U | 5 U | 121  | 6040 | 0.038 U | 3890 | 19.1   | 38.7 | 33   | 3670                                 |
| 07-090-SW-3 | 16.8 | 45.2 | 15.5 | 5.99 U | 5 U | 100  | 4360 | 0.038 U | 3640 | 18.8   | 39   | 33.5 | 3440                                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL<br>DISSOLVED<br>SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------------|----------|---------|-----------|---------|
| 07-090-SW-1 | 72                           | < 5.0    | 23      | < 0.05    | NR      |
| 07-090-SW-2 | 190                          | < 5.0    | 106     | < 0.05    | 0.02    |
| 07-090-SW-3 | 146                          | < 5.0    | 87      | < 0.05    | 0.01    |

**LEGEND**

SE1 - In Dry Fork Belt Creek below confluence with Galena Creek.  
SE2 - Before confluence with Dry Fork Belt Creek in Galena Creek, approx. 425'.  
SE3 - Upgradient of Block P. Tailings below confluence with Gold Rush Creek.  
SW1 - Same as sample SE1.  
SW2 - same as sample SE2.  
SW3 - Same as sample SE3.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Galena Creek Sampling</u>          | County: <u>Judith Basin</u>                  |
| Legal Description: <u>N/A</u>                         | Section(s): <u>N/A</u>                       |
| Mining District: <u>Hughesville</u>                   | Mine Type: <u>N/A</u>                        |
| Latitude: <u>N 47° 03' to 47° 05'</u>                 | Primary Drainage: <u>Dry Fork Belt Creek</u> |
| Longitude: <u>W 110° 38' to 110° 38'</u>              | USGS Code: <u>10030105</u>                   |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Galena Creek</u>      |
| Quad: <u>Barker</u>                                   | Date Investigated: <u>June 7, 1993</u>       |
| Inspectors: <u>Bullock, Babits, Flammang, Lasher,</u> | P.A. # <u>07-090</u>                         |
| <u>Clark/Pierson</u>                                  |  |
| Organization: <u>Pioneer Technical Services,</u>      |  |
| <u>Inc./Thomas, Dean and Hoskins, Inc.</u>            |  |

- The purpose of this sampling exercise was to characterize the impacts from the numerous mine sites along Galena Creek during a high-flow, storm event. Surface water and sediment samples were collected in the Dry Fork Belt Creek, and in Galena Creek between each potential source. This data has been applied to evaluating the following sites:
  - Block P Tailings - PA# 07-090
  - Lucky Strike/NE NE S7 - PA# 23-042
  - Marcelline Mine - PA# 23--022
  - Wright Lode - PA# 23-045
  - Edwards Lode - PA# 23-046
  - Belt Patent - PA# 23-035
  - Block P Mine - PA# 23-001
- Observed releases and exceedances of MCL/MCLGs and aquatic life criteria were evaluated on a site-specific basis on the inventory forms for each of these sites.



**Galena Creek PA# 07-090**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/07/93**

| SOLID MATRIX ANALYSES |            |                              |            |            |            |            |            |            |            |            |            |            |            |                 |
|-----------------------|------------|------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| Metals in soils       |            | Results per dry weight basis |            |            |            |            |            |            |            |            |            |            |            |                 |
| FIELD ID              | As (mg/Kg) | Ba (mg/Kg)                   | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | Cyanide (mg/Kg) |
| 07-090-SE-1           | 396        | 486                          | 9.4 J      | 7.7 J      | 8.5        | 182 J      | 51700      | 0.147 J    | 3120 J     | 25 J       | 705        | 5 U        | 1590 J     | NR              |
| 07-090-SE-2           | 140        | 97.3                         | 13.2 J     | 7 J        | 3.9        | 149 J      | 21600      | 0.037 J    | 2720 J     | 18 J       | 1070       | 3 U        | 2080 J     | 0.31 U          |
| 07-090-SE-3           | 196        | 123                          | 11.1 J     | 7.6 J      | 2.8        | 149 J      | 26700      | 0.045 J    | 4030 J     | 23 J       | 1110       | 4 U        | 1970 J     | 0.57            |
| 07-090-SE-4           | 272        | 147                          | 3.6 J      | 3.2 J      | 5.1        | 107 J      | 45900      | 0.097 J    | 651 J      | 6 J        | 1590       | 4 U        | 811 J      | NR              |
| 07-090-SE-5           | 368        | 213                          | 0.7 U      | 6.7 J      | 4.7        | 146 J      | 56400      | 0.214 J    | 975 J      | 9 J        | 1410       | 5 U        | 566 J      | NR              |
| 23-046-SE-6           | 379        | 220                          | 2.3 J      | 11.9 J     | 7.3        | 139 J      | 66400      | 0.275 J    | 1800 J     | 11 J       | 4040       | 5 U        | 562 J      | NR              |
| 07-090-SE-7           | 154        | 59                           | 0.8 J      | 3.6 J      | 3.7        | 106 J      | 25200      | 0.177 J    | 438 J      | 3 J        | 584        | 4 U        | 152 J      | NR              |
| 07-090-SE-8           | 255        | 218                          | 3 J        | 9 J        | 4.8        | 215 J      | 43700      | 0.161 J    | 2120 J     | 19 J       | 3390       | 5 U        | 749 J      | NR              |
| 07-090-SE-9           | 43         | 222                          | 2.6 J      | 9.4 J      | 3.6        | 243 J      | 21400      | 0.057 J    | 2600 J     | 24 J       | 432        | 5 U        | 632 J      | NR              |
| 07-090-SE-10          | 28         | 88.8                         | 0.6 U      | 4.4 J      | 1.8        | 140 J      | 13400      | 0.03 J     | 653 J      | 9 J        | 82         | 4 U        | 180 J      | NR              |
| 07-090-SE-11          | 101        | 608                          | 33.3 J     | 13.8 J     | 8.5        | 1450 J     | 50200      | 0.178 J    | 10100 J    | 78 J       | 6800       | 15         | 7000 J     | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

| WATER MATRIX ANALYSES |        |                 |        |        |      |      |       |         |      |        |      |        |                 |                |
|-----------------------|--------|-----------------|--------|--------|------|------|-------|---------|------|--------|------|--------|-----------------|----------------|
| Metals in Water       |        | Results in ug/L |        |        |      |      |       |         |      |        |      |        |                 | HARDNESS CALC. |
| FIELD ID              | As     | Ba              | Cd     | Co     | Cr   | Cu   | Fe    | Hg      | Mn   | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) |                |
| 07-090-SW-1           | 9.92   | 40.7            | 2.9    | 5.99 U | 5 U  | 23.5 | 1390  | 0.038 U | 790  | 8.78 U | 6.75 | 36.9   | 632             | 66.2           |
| 07-090-SW-2           | 54.5   | 45.4            | 16.3   | 5.99 U | 5 U  | 121  | 6040  | 0.038 U | 3890 | 19.1   | 38.7 | 33     | 3670            | 105            |
| 07-090-SW-3           | 16.8   | 45.2            | 15.5   | 5.99 U | 5 U  | 100  | 4360  | 0.038 U | 3640 | 18.8   | 39   | 33.5   | 3440            | 97.4           |
| 07-090-SW-4           | 38.8   | 22.7            | 36.5   | 9.03   | 5 U  | 246  | 11600 | 0.038 U | 8670 | 43.4   | 121  | 53.8   | 7750            | 131            |
| 07-090-SW-5           | 38.7   | 23              | 34.4   | 8.73   | 5 U  | 256  | 12600 | 0.038 U | 8940 | 45.9   | 59.6 | 50     | 7980            | 135            |
| 23-046-SW-6           | 13.9   | 20.6            | 13.2   | 5.99 U | 5 U  | 57.8 | 5150  | 0.087   | 869  | 10.9   | 14.5 | 18.3 U | 2130            | 76.9           |
| 07-090-SW-7           | 33     | 23.7            | 34.7   | 6.77   | 5 U  | 265  | 12300 | 0.038 U | 8090 | 39.4   | 68.6 | 50.8   | 7790            | 142            |
| 07-090-SW-8           | 29     | 23.6            | 30.2   | 5.99 U | 5 U  | 239  | 11800 | 0.038 U | 7560 | 41.5   | 51.1 | 38.9   | 7090            | 137            |
| 07-090-SW-9           | 0.98 U | 25.1            | 2.55 U | 5.99 U | 5.6  | 150  | 1370  | 0.038 U | 558  | 8.78 U | 37.6 | 32.1   | 585             | 107            |
| 07-090-SW-10          | 2.09   | 20              | 2.55 U | 5.99 U | 5.13 | 6.77 | 403   | 0.038 U | 77.4 | 8.78 U | 2.52 | 33     | 54.3            | 85.5           |
| 07-090-SW-11          | 0.98 U | 26.5            | 3.9    | 5.99 U | 5 U  | 234  | 1950  | 0.038 U | 840  | 8.78 U | 64   | 32.9   | 861             | 115            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

| Wet Chemistry   |        | Results in mg/l |         |           |         |  |
|-----------------|--------|-----------------|---------|-----------|---------|--|
| TOTAL DISSOLVED |        |                 |         |           |         |  |
| Field I.D.      | SOLIDS | CHLORIDE        | SULFATE | NO3/NO2-N | CYANIDE |  |
| 07-090-SW-1     | 72     | < 5.0           | 23      | < 0.05    | NR      |  |
| 07-090-SW-2     | 190    | < 5.0           | 106     | < 0.05    | 0.02    |  |
| 07-090-SW-3     | 146    | < 5.0           | 87      | < 0.05    | 0.01    |  |
| 07-090-SW-4     | 318    | < 5.0           | 181     | 0.05      | NR      |  |
| 07-090-SW-5     | 308    | < 5.0           | 182     | 0.06      | NR      |  |
| 23-046-SW-6     | 141    | < 5.0           | 60      | < 0.05    | NR      |  |
| 07-090-SW-7     | 320    | < 5.0           | 185     | 0.07      | NR      |  |
| 07-090-SW-8     | 274    | < 5.0           | 178     | 0.06      | NR      |  |
| 07-090-SW-9     | 182    | < 5.0           | 86      | 0.07      | NR      |  |
| 07-090-SW-10    | 130    | < 5.0           | 35      | 0.05      | NR      |  |
| 07-090-SW-11    | 218    | < 5.0           | 113     | < 0.05    | NR      |  |

| LEGEND       |  |                            |
|--------------|--|----------------------------|
| 07-090-SE-1  | Dry Fork of Belt Ck. downstream of confluence with of Galena Ck. | 07-090-SW-1 Same as SE-1   |
| 07-090-SE-2  | Galena Ck. upstream of confluence, downstream of Block P Tails   | 07-090-SW-2 Same as SE-2   |
| 07-090-SE-3  | Galena Ck. upstream of Block P Tails, downstream of Lucky Strike | 07-090-SW-3 Same as SE-3   |
| 07-090-SE-4  | Galena Ck. upstream of the Lucky Strike                          | 07-090-SW-4 Same as SE-4   |
| 07-090-SE-5  | Galena Ck. downstream of the Marcelline                          | 07-090-SW-5 Same as SE-5   |
| 23-046-SE-6  | Unnamed trib. to Galena Ck. @ the Marcelline                     | 23-046-SW-6 Same as SE-6   |
| 07-090-SE-7  | Galena Ck. upstream of the Marcelline, downstream of Belt Patent | 07-090-SW-7 Same as SE-7   |
| 07-090-SE-8  | Galena Ck. upstream of the Belt Patent, downstream of Block P    | 07-090-SW-8 Same as SE-8   |
| 07-090-SE-9  | Galena Ck. upstream of the Block P Mine                          | 07-090-SW-9 Same as SE-9   |
| 07-090-SE-10 | Green Creek  | 07-090-SW-10 Same as SE-10 |
| 07-090-SE-11 | Daisy Creek  | 07-090-SW-11 Same as SE-11 |

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Bon Ton</u>                        | County: <u>Cascade</u>                       |
| Legal Description: T <u>15N</u> R <u>8E</u>           | Section(s): <u>SE 1/4, SE 1/4, Sec. 1</u>    |
| Mining District: <u>Hughesville</u>                   | Mine Type: <u>Hardrock/Ag, Pb, Zn</u>        |
| Latitude: <u>N 47° 04' 58"</u>                        | Primary Drainage: <u>Dry Fork Belt Creek</u> |
| Longitude: <u>W 110° 38' 52"</u>                      | USGS Code: <u>10030105</u>                   |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>McKay Gulch</u>       |
| Quad: <u>Barker</u>                                   | Date Investigated: <u>June 3, 1993</u>       |
| Inspectors: <u>Bullock, Flammang, Clark</u>           | P.A. # <u>07-094</u>                         |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- The volume of material tentatively identified as tailings associated with this site was estimated to be approximately 1,200 cubic yards; however, no elements were elevated more than three times background (based on XRF analytical data). Lead and zinc were moderately elevated above background concentrations.
- The volume of waste rock associated with this site was estimated to be approximately 3,300 mg/kg. The following elements were elevated at least three times background:  
Arsenic: 523J to 1,330J mg/kg      Manganese: 41,100 mg/kg  
Cadmium: 187 mg/kg      Lead: 9,140 to 12,300 mg/kg  
Iron: 109,000 mg/kg      Antimony: 61.8J mg/kg  
Mercury: 0.556 mg/kg      Zinc: 50,900 mg/kg
- One discharging adit was identified at the site during the investigation. MCLs were exceeded for cadmium and antimony in the adit discharge. The acute aquatic life criteria for zinc was exceeded in the adit discharge. The chronic aquatic life criteria for iron, cadmium, and zinc were also exceeded. The pH measurement in the adit discharge was 6.10 and the specific conductance was 980 umhos/cm.
- The intermittent McKay Gulch was flowing directly through the site (through the waste rock dumps in places). Observed releases to McKay Gulch were documented for arsenic, cadmium, iron, manganese, lead, and zinc. The MCL for cadmium was exceeded in the downstream McKay Gulch sample. Acute and chronic aquatic life criteria for zinc were exceeded in the downstream sample; also, chronic aquatic life criteria for iron, cadmium, and lead were exceeded in the downstream sample. No MCLs or aquatic life criteria were exceeded in the upstream sample. All MCL and aquatic life criteria exceedances in McKay Gulch were directly attributable to the site.
- Stream erosion created potentially hazardous (unstable) slopes on WR-1 and WR-3.
- The remains of a wooden building on site was classified a hazardous structure.

**Bon Ton PA# 07-094**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/03/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 07-094-CONC | 587 J      | 127 J      | 90.2       | 28.3       | 13.1 J     | 25.6 J     | 41100      | 0.132      | 156000     | 701        | 2610       | 98.5 J     | 93000      | NR              |
| 07-094-SE-1 | 51.9 J     | 75.7 J     | 2.6        | 6.87       | 16.9 J     | 16.1 J     | 15600      | 0.035      | 959        | 25.1       | 335        | 5.17 UJ    | 945        | NR              |
| 07-094-SE-2 | 219 J      | 179 J      | 60.3       | 4.23       | 10.3 J     | 40.5 J     | 33400      | 0.105      | 30700      | 166        | 287        | 25.2 J     | 21500      | NR              |
| 07-094-WR-1 | 523 J      | 67.3 J     | 13.5       | 1.28 U     | 3.29 J     | 42.1 J     | 61700      | 0.556      | 11300      | 51.5       | 9140       | 9.24 J     | 3860       | NR              |
| 07-094-WR-2 | 1330 J     | 36.8 J     | 187.0      | 3.27       | 8.98 J     | 39.3 J     | 109000     | 0.159      | 41100      | 175        | 12300      | 61.8 J     | 50900      | NR              |
| BACKGROUND  | 122 J      | 441 J      | 5          | 9.66       | 26.5 J     | 22.7 J     | 33300      | 0.071      | 11900      | 75         | 375        | 4.24 J     | 1570       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 07-094-WR-1 | 9.4            | 294                            | 143                     | -151                             | 0.29             | 5.32             | 3.79             | 166                              | -23.1                            |
| 07-094-WR-2 | 23.9           | 747                            | 182                     | -565                             | 10.4             | 9.58             | 3.99             | 299                              | -117                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co     | Cr  | Cu     | Fe   | Hg      | Mn   | Ni   | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|------|--------|--------|-----|--------|------|---------|------|------|------|--------|-----------------|----------------|
| 07-094-GW-1 | 33.9 | 11.5 | 20.1   | 5.99 U | 5 U | 4.4 J  | 7060 | 0.038 U | 7920 | 54.9 | 10.2 | 26.6   | 13000 JX        | 609            |
| 07-094-SW-1 | 1.41 | 26.8 | 2.55 U | 5.99 U | 5 U | 5.27 J | 35.9 | 0.038 U | 9.9  | 12.1 | 4.12 | 18.3 U | 24.7 JX         | 202            |
| 07-094-SW-2 | 14.1 | 16   | 8.27   | 6.17   | 5 U | 11.2 J | 2870 | 0.038 U | 2090 | 18.9 | 16.6 | 18.3 U | 3340 JX         | 359            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD I.D.  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 07-094-GW-1 | 764                    | < 5.0    | 353     | < 0.05    | NR      |
| 07-094-SW-1 | 221                    | < 5.0    | 7       | < 0.05    | NR      |
| 07-094-SW-2 | 427                    | < 5.0    | 161     | < 0.05    | NR      |

**LEGEND**

CONC - Small concentrate pile Northeast of mill building.  
SE1 - Approx. 25' upstream from waste rock dump 3.  
SE2 - Downgradient of alleged tailings, approx. 10'.  
WR1 - Composite of subsamples WR1A and 1B.  
WR2 - Composite of subsamples WR2A and 2B.  
BACKGROUND - From the Bon Ton Mine (07-094-SS-1).

GW1 - Discharge from a collapsed adit.  
SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |   |
|--|---|
| Mine/Site Name: <u>Vilipa</u>                    | County: <u>Cascade</u>                        |
| Legal Description: T <u>14N</u> R <u>8E</u>      | Section(s): <u>SW 1/4, NE 1/4, Sec. 16</u>    |
| Mining District: <u>Neihart</u>                  | Mine Type: <u>Hardrock/Ag. Au, Pb, Zn, Cu</u> |
| Latitude: <u>N 46° 58' 31"</u>                   | Primary Drainage: <u>Belt Creek</u>           |
| Longitude: <u>W 110° 42' 40"</u>                 | USGS Code: <u>10030105</u>                    |
| Land Status: <u>Private/Public</u>               | Secondary Drainage: <u>McKay Creek</u>        |
| Quad: <u>Neihart</u>                             | Date Investigated: <u>July 29, 1993</u>       |
| Inspectors: <u>Bullock, Clark/Pierson</u>        | P.A. # <u>07-080</u>                          |
| Organization: <u>Pioneer Technical Services,</u> |   |
| <u>Inc./Thomas, Dean and Hoskins, Inc.</u>       |   |

- There were no mill tailings observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 5,700 cubic yards. The following elements were elevated at least three times background:  
Copper: 108J to 151J mg/kg      Mercury: 0.397J to 0.917 mg/kg
- One minor adit discharge, two shafts with small amounts of accumulated precipitation, and one small seep at the toe of a waste rock dump were identified as groundwater features at the site during the investigation; however, none of these water sources were sampled. Instead, an additional sample was collected from McKay Creek (in the central section of the site) to assess potential impacts.
- McKay Creek flowed directly through the site (WR-4 was actively eroding into McKay Creek); surface water samples were collected upstream, near the center of the site, and downstream from the site. An observed release to McKay creek was documented for copper. No MCLs were exceeded in any of the samples. The acute aquatic life criteria exceedance for copper was directly attributable to the site. Downstream sediment samples indicated elevated concentrations (greater than three times upstream) of copper, mercury, and manganese.
- Four potentially hazardous mine openings were identified at the site including three open but partially collapsed shafts and one open adit. One of the cabins located on site was collapsing and potentially hazardous.



**Vilipa PA# 07-080**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/29/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 07-080-SE-1 | 8             | 135 J         | 6.9           | 23.4 J        | 24.4          | 283 J         | 19500         | 0.089 J       | 1820          | 14 J          | 242 J         | 8 U           | 650 J         | NR                 |
| 07-080-SE-2 | 14            | 188 J         | 14.6          | 72 J          | 14.5          | 425 J         | 24300         | 0.074 J       | 3840          | 26 J          | 899 J         | 8 U           | 1170 J        | NR                 |
| 07-080-SE-3 | 5 U           | 61.3 J        | 3.3           | 8.2 J         | 23.9          | 33.8 J        | 10700         | 0.03 J        | 372           | 12 J          | 100 J         | 6 U           | 315 J         | NR                 |
| 07-080-WR-1 | 14            | 137 J         | 2.1           | 5 J           | 17.6          | 108 J         | 18100         | 0.917 J       | 294           | 10 J          | 775 J         | 7 U           | 258 J         | NR                 |
| 07-080-WR-2 | 20            | 130 J         | 1.6           | 6 J           | 36.9          | 151 J         | 22000         | 0.397 J       | 217           | 6 J           | 530 J         | 7 U           | 126 J         | NR                 |
| BACKGROUND  | 10.5          | 131           | 1.4           | 6.83          | 22.2          | 26.1          | 20600         | 0.048 U       | 607           | 15.6          | 667           | 3.39 UJ       | 548           | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR ACID BASE<br>t/1000t | NEUTRAL POTENT.<br>t/1000t | SULFUR ACID BASE POTENT.<br>t/1000t | SULFATE SULFUR<br>% | PYRITIC SULFUR<br>% | ORGANIC SULFUR<br>% | PYRITIC SULFUR ACID BASE<br>t/1000t | SULFUR ACID BASE POTENT.<br>t/1000t |
|-------------|-------------------|-----------------------------------|----------------------------|-------------------------------------|---------------------|---------------------|---------------------|-------------------------------------|-------------------------------------|
| 07-080-WR-1 | 0.88              | 27.5                              | 20.6                       | -6.85                               | 0.18                | 0.39                | 0.31                | 12.2                                | 8.45                                |
| 07-080-WR-2 | 0.20              | 6.25                              | 1.78                       | -4.47                               | 0.13                | 0.01                | 0.06                | 0.31                                | 1.46                                |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co    | Cr     | Cu   | Fe    | Hg    | Mn     | Ni     | Pb    | Sb     | Zn (mg CaCO3/L) | HARDNESS<br>CALC. |
|-------------|------|------|--------|-------|--------|------|-------|-------|--------|--------|-------|--------|-----------------|-------------------|
| 07-080-SW-1 | 3.22 | 21.8 | 2.57 U | 9.7 U | 6.83 U | 18.9 | 143 J | 0.11  | 24.9   | 12.7 U | 1.8 J | 30.7 U | 201             | 36.6              |
| 07-080-SW-2 | 3.51 | 21.3 | 2.57 U | 9.7 U | 6.83 U | 20.1 | 139 J | 0.12  | 23.3   | 12.7 U | 1.5 J | 30.7 U | 203             | 34.6              |
| 07-080-SW-3 | 4.05 | 17.9 | 2.57 U | 9.7 U | 6.83 U | 4.83 | 102 J | 0.065 | 4.08 U | 12.7 U | 1 J   | 30.7 U | 71.8            | 33.9              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 07-080-SW-1 | 87                     | < 5.0    | 27      | < 0.05    | NR      |
| 07-080-SW-2 | 102                    | < 5.0    | 25      | < 0.05    | NR      |
| 07-080-SW-3 | 85                     | < 5.0    | 18      | < 0.05    | NR      |

**LEGEND**

SE1 - Downstream of site on McKay Creek  
SE2 - McKay Creek between WR-3 and WR-4  
SE3 - Upstream from site on McKay Creek  
WR1 - Composite of subsamples WR1A, 2A, 3A, 3B, and 3C.  
BACKGROUND - From the Silver Dyke Adit (07-135-SS-1).

SW1 - Same as SE-1  
SW2 - Same as SE-2  
SW3 - Same as SE-3

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |  |
|--|--|
| Mine/Site Name: <u>Molton</u>  | County: <u>Cascade</u>                     |
| Legal Description: <u>T 14N R 8E</u>   | Section(s): <u>SW 1/4, SE 1/4, Sec. 29</u> |
| Mining District: <u>Neihart</u>  | Mine Type: <u>Hardrock/Ag, Pb, Zn</u>      |
| Latitude: <u>N 46° 56' 21"</u>   | Primary Drainage: <u>Belt Creek</u>        |
| Longitude: <u>W 110° 44' 07"</u>   | USGS Code: <u>10030105</u>                 |
| Land Status: <u>Private/Public</u>   | Secondary Drainage: <u>Rock Creek</u>      |
| Quad: <u>Neihart</u>   | Date Investigated: <u>July 29, 199</u>     |
| Inspectors: <u>Bullock, Clark/Pierson</u>  | P.A. # <u>07-084</u>                       |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |  |

- There were no tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be approximately 100,000 cubic yards. The following elements were elevated at least three times background:
  - Arsenic: 274 mg/kg
  - Copper: 165J mg/kg
  - Mercury: 0.622J mg/kg
- There were two adit discharges associated with this site. GW-1 was a sample from the discharge associated with the large adit and dump in the drainage directly upstream from the main level shaft area. This discharge had a flow of approximately 40 gpm, a pH of 7.9, and a specific conductance of 450 umhos/cm. None of the MCLs or MCLGs were exceeded in this sample. The acute aquatic life criteria for zinc and the chronic aquatic life criteria for lead and zinc were exceeded in this sample. GW-2 was a sample from the discharge associated with the caved adit on the hillside north of the main level shaft area. This discharge had a flow of approximately 15 gpm, a pH of 5.75, and a specific conductance of 930 umhos/cm. The MCL/MCLGs for cadmium, nickel, and antimony were exceeded in this sample. Acute and chronic aquatic life criteria were exceeded for cadmium, copper, lead and zinc. This discharge seeped back into the ground prior to reaching the drainage below.
- Rock Creek, a small perennial tributary to Belt Creek flowed though the site. Surface water samples did not document an observed release of any of the metals analyzed. The MCL for cadmium and aquatic life criteria for lead and zinc were exceeded both up and down stream of this site and therefore, were not directly attributable to this site. The stream sediment data did document an observed release of mercury.
- Six large transformers remained on site, possibly containing PCBs.

**Molton PA# 07-084**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/29/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 07-084-SE-1 | 102 J      | 348 J      | 62.5 J     | 35.1       | 25.7 J     | 123 J      | 34400      | 2.75 JX    | 16200      | 31         | 4440       | 21 J       | 11400 J    | NR              |
| 07-084-SE-2 | 149 J      | 292 J      | 23.6 J     | 63.5       | 29 J       | 113 J      | 87500      | 0.351 JX   | 20400      | 34         | 5320       | 9 J        | 4890 J     | NR              |
| 07-084-WR-1 | 79         | 470 J      | 24         | 10 J       | 7.4        | 40.8 J     | 31200      | 0.144 J    | 16000      | 24 J       | 4230 J     | 8 J        | 5290 J     | NR              |
| 07-084-WR-2 | 274        | 889 J      | 3.6        | 5.7 J      | 42.6       | 165 J      | 37000      | 0.622 J    | 1230       | 19 J       | 4250 J     | 8 J        | 705 J      | NR              |
| BACKGROUND  | 53.3       | 828        | 15.3       | 11.6       | 72.7       | 50.1       | 30600      | 0.051 U    | 10400      | 91.5       | 5110       | 2.99 UJ    | 3530       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 07-084-WR-1 | 1.77           | 55.3                           | 29.7                     | -25.6                            | 0.30             | 0.74             | 0.73             | 23.1                             | 6.56                             |
| 07-084-WR-2 | 0.86           | 26.9                           | 12.3                     | -14.5                            | 0.60             | 0.07             | 0.19             | 2.19                             | 10.1                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd   | Co    | Cr     | Cu     | Fe    | Hg     | Mn    | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|------|-------|--------|--------|-------|--------|-------|--------|--------|--------|-----------------|----------------|
| 07-084-GW-1 | 2.64 J | 20.3 | 2.83 | 9.7 U | 6.83 U | 1.55 U | 199   | 0.13 J | 1750  | 12.7 U | 10     | 30.7 U | 2610            | 204            |
| 07-084-GW-2 | 2.48 J | 23.8 | 173  | 35.1  | 6.83 U | 72.1   | 210   | 0.1 J  | 51000 | 231    | 775    | 43     | 33100           | 362            |
| 07-084-SW-1 | 2.93   | 22.8 | 34.3 | 9.7 U | 6.83 U | 11.5   | 582 J | 0.094  | 5900  | 38.2   | 20.4 J | 30.7 U | 11000           | 130            |
| 07-084-SW-2 | 2.46   | 26.9 | 33.3 | 9.7 U | 6.83 U | 11.5   | 869 J | 0.094  | 6890  | 33.3   | 21.8 J | 30.7 U | 11200           | 105            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 07-084-GW-1 | 516                    | < 5.0    | 4800    | < 0.05    | NR      |
| 07-084-GW-2 | 807                    | < 5.0    | 168     | < 0.05    | NR      |
| 07-084-SW-1 | 243                    | < 5.0    | 149     | < 0.05    | NR      |
| 07-084-SW-2 | 189                    | < 5.0    | 130     | < 0.05    | NR      |

**LEGEND**

SE1 - Rock Creek downgradient; 330' below waste rock dump 3.  
 SE2 - Rock Creek; approximately 100' above waste rock dump 2.  
 WR1 - Composite of subsamples WR1A, 2A, and 2B.  
 WR2 - Composite of subsamples WR3A, 3B, 3C, and 4A.  
 BACKGROUND - From the Compromise Mine (07-100-SS-1).

GW1 - Adit at waste rock dump 2 (Adit #2).  
 GW2 - Adit on North hill above shaft.  
 SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Evening Star Mine/Millsite</u>     | County: <u>Cascade</u>                     |
| Legal Description: <u>T 14N R 8E</u>                  | Section(s): <u>NW 1/4, SW 1/4, Sec. 29</u> |
| Mining District: <u>Neihart</u>                       | Mine Type: <u>Hardrock/Ag, Pb, Zn</u>      |
| Latitude: <u>N 46° 56' 39"</u>                        | Primary Drainage: <u>Belt Creek</u>        |
| Longitude: <u>W 110° 44' 46"</u>                      | USGS Code: <u>10030105</u>                 |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Belt Creek</u>      |
| Quad: <u>Neihart</u>                                  | Date Investigated: <u>June 2, 1993</u>     |
| Inspectors: <u>Bullock, Flammang, Clark</u>           | P.A. # <u>07-087</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- The volume of tailings associated with this site was estimated to be approximately 1,200 cubic yards. Precipitation was observed to have collected on TP-1. The following elements were elevated at least three times background:  
Barium: 4,150 mg/kg      Mercury: 0.277 mg/kg
- The volume of waste rock associated with this site was estimated to be approximately 9,984 cubic yards. The following elements were elevated at least three times background:  
Copper: 160 mg/kg      Mercury: 0.186 to 0.301 mg/kg
- One discharging adit was observed at the site during the investigation; after flowing through WR-1, the discharge seeped into the ground. No MCLs were exceeded in the adit discharge; however, the acute and chronic aquatic life criteria for zinc were exceeded. The pH measurement in the adit discharge was 6.48. No other groundwater or surface water samples were collected during the investigation
- One potentially hazardous adit opening was identified at the site; also, nine potentially hazardous structures were identified.
- The mill building contained numerous barrels and bags of various hazardous and unknown materials; all barrels were in poor condition.



**Evening Star Mill PA# 07-087**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/02/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 07-087-TP-1 | 104        | 4150       | 32.1       | 6.49       | 29.3       | 98.1       | 30000      | 0.277      | 11000      | 90.9       | 5860       | 5.47 J     | 7730       | 1.371 U         |
| 07-087-WR-1 | 86.3       | 233        | 26.6       | 13.4       | 10.6       | 160        | 45000      | 0.301      | 12000      | 87.5       | 14800      | 3.58 J     | 6840       | NR              |
| 07-087-WR-2 | 34 J       | 640 J      | 7.9        | 17.5       | 35.5 J     | 46.3 J     | 34700      | 0.186      | 8150       | 93.4       | 5370       | 6.56 J     | 1910       | NR              |
| BACKGROUND  | 53.3       | 828        | 15         | 11.6       | 72.7       | 50.1       | 30600      | 0.051 U    | 10400      | 91.5       | 5110       | 2.99 UJ    | 3530       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID   | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 07-087-TP1 | 1.24           | 38.7                           | 28.6                     | -10                              | 0.26             | 0.68             | 0.3              | 21.2                             | 7.36                             |
| 07-087-WR1 | 2.47           | 77.2                           | 34                       | -43                              | 0.28             | 1.22             | 0.97             | 38.1                             | -4.14                            |
| 07-087-WR2 | 0.76           | 23.7                           | 64.6                     | 40.8                             | 0.23             | 0.24             | 0.29             | 7.5                              | 57.1                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba  | Cd     | Co     | Cr     | Cu     | Fe  | Hg      | Mn   | Ni   | Pb   | Sb     | HARDNESS CALC. Zn (mg CaCO3/L) |
|-------------|--------|-----|--------|--------|--------|--------|-----|---------|------|------|------|--------|--------------------------------|
| 07-087-GW-1 | 0.98 U | 6.4 | 2.55 U | 5.99 U | 8.93 J | 3.23 J | 184 | 0.038 U | 8560 | 86.8 | 6.64 | 18.3 U | 606 JX 489                     |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 07-087-GW-1 | 613                    | < 5.0    | 215     | < 0.05    | NR      |

**LEGEND**

TP1 - Composite of subsamples TP2A, 1A, and 1B.

WR1 - Composite of subsamples WR1A, 1B, and 1C.

WR2 - Sample of the WR2 subsample.

BACKGROUND - From the Compromise Mine (07-100-SS-1).

GW1 - Sample from the Evening Star adit.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Compromise  
Legal Description: T 14N R 8E  
Mining District: Neihart  
Latitude: N 46° 56' 16"  
Longitude: W 110° 44' 05"  
Land Status: Private/Public  
Quad: Neihart  
Inspectors: Bullock, Flammang, Clark  
Organization: Pioneer Technical Services, Inc.

County: Cascade  
Section(s): NW 1/4, NE 1/4, Sec. 32  
Mine Type: Hardrock/Ag, Au, Pb, Zn  
Primary Drainage: Belt Creek  
USGS Code: 10030105  
Secondary Drainage: Compromise Gulch  
Date Investigated: June 1, 1993  
P.A. # 07-100

- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 600 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 164 to 177 mg/kg      Mercury: 0.245 to 0.516 mg/kg
- Two discharging adits and one discharging shaft were identified at the site. MCLs for cadmium and nickel were exceeded in the shaft discharge (GW-1), no MCLs were exceeded in either of the adit discharges. Acute and chronic aquatic life criteria were exceeded for zinc in the shaft discharge as well as chronic aquatic life criteria for iron, mercury, cadmium and lead. Acute and chronic aquatic life criteria were exceeded for zinc in both adit discharges (GW-2 and GW-3), and chronic aquatic life criteria were exceeded for mercury and lead in both adit discharges. Chronic aquatic life criteria were exceeded for iron and copper in the Adit #1 discharge (GW-2).
- The intermittent Compromise Gulch was flowing directly through the site. Three surface water samples were collected from Compromise Gulch during the investigation (upstream, center of site, and downstream). Downstream iron, manganese, nickel, and zinc concentrations were elevated at least three times the upstream concentrations, but were not significantly elevated in the source samples; thus not directly attributable to this site. The MCL/MCLG for nickel was exceeded in the downstream sample. Acute and chronic aquatic life criteria were exceeded for several elements in both the upstream and downstream samples, and were therefore not directly attributable to this site. An observed release to Compromise Gulch was documented for arsenic (sediment).
- One potentially hazardous mine opening (Shaft #1, fenced) was identified at the site. Potentially hazardous structures included the headframe associated with Shaft #1 and two highwalls ranging in height from 15 to 30 feet.
- A recreational cabin was identified at the south end of the site and the site was also determined to be in close proximity to the town of Neihart.

**Compromise PA# 07-100**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/01/93**

| SOLID MATRIX ANALYSES   |                |                                     |                               |                                       |                  |                  |                  |                                       |                                       |            |            |            |            |                 |
|---|----------------|-------------------------------------|-------------------------------|---------------------------------------|------------------|------------------|------------------|---------------------------------------|---------------------------------------|------------|------------|------------|------------|-----------------|
| Metals in soils   |                | Results per dry weight basis        |                               |                                       |                  |                  |                  |                                       |                                       |            |            |            |            |                 |
| FIELD ID  | As (mg/Kg)     | Ba (mg/Kg)                          | Cd (mg/Kg)                    | Co (mg/Kg)                            | Cr (mg/Kg)       | Cu (mg/Kg)       | Fe (mg/Kg)       | Hg (mg/Kg)                            | Mn (mg/Kg)                            | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 07-100-SE-1   | 56.2           | 690                                 | 22.5                          | 163                                   | 11.1             | 35.6             | 30100            | 0.064 U                               | 86100                                 | 604        | 772        | 4.18 UJ    | 5600       | NR              |
| 07-100-SE-2   | 78.7           | 1250                                | 10.7                          | 9.61                                  | 11.5             | 38.6             | 24600            | 0.147                                 | 8700                                  | 66.8       | 3690       | 3.19 UJ    | 2470       | NR              |
| 07-100-SE-3   | 6.93           | 146                                 | 0.7                           | 8.98                                  | 10.4             | 9.04             | 23600            | 0.059 U                               | 854                                   | 15.6       | 31.7       | 2.74 UJ    | 189        | NR              |
| 07-100-WR-1   | 164            | 323                                 | 19.4                          | 16.5                                  | 8.64             | 90.7             | 43600            | 0.516                                 | 14500                                 | 89.8       | 6680       | 3.59 UJ    | 3810       | NR              |
| 07-100-WR-4   | 177            | 311                                 | 29.9                          | 20.7                                  | 9.29             | 65.4             | 43500            | 0.245                                 | 8560                                  | 63.5       | 3160       | 3.38 UJ    | 7520       | NR              |
| BACKGROUND  | 53.3           | 828                                 | 15.3                          | 11.6                                  | 72.7             | 50.1             | 30600            | 0.051 U                               | 10400                                 | 91.5       | 5110       | 2.99 UJ    | 3530       | NR              |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                |                                     |                               |                                       |                  |                  |                  |                                       |                                       |            |            |            |            |                 |
| Acid/Base Accounting  |                |                                     |                               |                                       |                  |                  |                  |                                       |                                       |            |            |            |            |                 |
| FIELD ID  | TOTAL SULFUR % | TOTAL SULFUR ACID BASE $\mu$ /1000t | NEUTRAL. POTENT. $\mu$ /1000t | SULFUR ACID BASE POTENT. $\mu$ /1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE $\mu$ /1000t | SULFUR ACID BASE POTENT. $\mu$ /1000t |            |            |            |            |                 |
| 07-100-WR1  | 1.12           | 35                                  | 41.4                          | 6.38                                  | 0.21             | 0.48             | 0.43             | 15                                    | 26.4                                  |            |            |            |            |                 |

| WATER MATRIX ANALYSES   |                        |                 |         |           |         |      |         |       |          |        |        |        |                 |                |
|---|------------------------|-----------------|---------|-----------|---------|------|---------|-------|----------|--------|--------|--------|-----------------|----------------|
| Metals in Water   |                        | Results in ug/L |         |           |         |      |         |       |          |        |        |        |                 |                |
| FIELD ID  | As                     | Ba              | Cd      | Co        | Cr      | Cu   | Fe      | Hg    | Mn       | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
| 07-100-GW-1   | 7.61                   | 7.73            | 10.2 J  | 80.7      | 12.6    | 25.1 | 16600 J | 0.200 | 45200 JX | 447    | 34 J   | 18.3 U | 8780            | 490            |
| 07-100-GW-2   | 3.72                   | 74.3            | 2.55 U  | 5.99 U    | 5 U     | 10.6 | 1380 J  | 0.210 | 140 JX   | 47.8   | 11.2 J | 18.3 U | 164             | 81.1           |
| 07-100-GW-3   | 3.48                   | 22.2            | 2.55 U  | 5.99 U    | 5 U     | 5.77 | 199 J   | 0.100 | 60.4 JX  | 8.78 U | 4.21 J | 18.3 U | 165             | 50.5           |
| 07-100-SW-1   | 6.17                   | 11              | 2.55 U  | 10.9      | 5 U     | 15   | 12500 J | 0.160 | 7450 JX  | 106    | 123 J  | 18.3 U | 3660            | 262            |
| 07-100-SW-2   | 2.98                   | 43.2            | 2.55 U  | 5.99 U    | 5 U     | 13.1 | 152 J   | 0.170 | 71.8 JX  | 8.78 U | 9.77 J | 18.3 U | 454             | 57.7           |
| 07-100-SW-3   | 4.53                   | 171             | 2.55 U  | 5.99 U    | 5 U     | 14.1 | 760 J   | 0.230 | 358 JX   | 9.57   | 126 J  | 18.3 U | 310             | 56.7           |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                        |                 |         |           |         |      |         |       |          |        |        |        |                 |                |
| Wet Chemistry   |                        |                 |         |           |         |      |         |       |          |        |        |        |                 |                |
| FIELD ID  | TOTAL DISSOLVED SOLIDS | CHLORIDE        | SULFATE | NO3/NO2-N | CYANIDE |      |         |       |          |        |        |        |                 |                |
| 07-100-GW-1   | 845                    | < 5.0           | 506     | 0.08      | NR      |      |         |       |          |        |        |        |                 |                |
| 07-100-GW-2   | 124                    | < 5.0           | 26      | < 0.05    | NR      |      |         |       |          |        |        |        |                 |                |
| 07-100-GW-3   | 79                     | < 5.0           | 15      | 0.05      | NR      |      |         |       |          |        |        |        |                 |                |
| 07-100-SW-1   | 394                    | < 5.0           | 246     | < 0.05    | NR      |      |         |       |          |        |        |        |                 |                |
| 07-100-SW-2   | 80                     | < 5.0           | 22      | < 0.05    | NR      |      |         |       |          |        |        |        |                 |                |
| 07-100-SW-3   | 74                     | < 5.0           | 21      | < 0.05    | NR      |      |         |       |          |        |        |        |                 |                |

**LEGEND**

SE1 - Below small footbridge in bend in road to cabin, approx. 200' South of cabin.

SE2 - Below confluence of adit #2 with Compromise Gulch stream.

SE3 - Upgradient, approx. 200' above waste rock dump 5.

WR1 - Composite of subsamples WR1A, 1B, and 1C.

WR4 - Composite of subsamples WR4A, 4B, 4C, 5A, 5B, 5c, 6A, 6B, and 6C.

BACKGROUND - 200' Northeast from adit #3; from the Compromise Mine (07-100-S3-1).

GW1 - From shaft #1- bailer grab from 10' below SW1.

GW2 - Collapsed adit #1 - seep.

GW3 - Collapsed adit #2 - seep.

SW1 - Same as sample SE1.

SW2 - Same as sample SE2.

SW3 - Same as sample SE3.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |   |
|--|---|
| Mine/Site Name: <u>Carpenter Creek Tailings</u>                                      | County: <u>Cascade</u>  |
| Legal Description: T <u>14N</u> R <u>8E</u>  | Section(s): <u>SE 1/4, SW 1/4, Sec. 16; NE 1/4, NW 1/4, Sec. 21</u> |
| Mining District: <u>Niehart</u>  | Mine Type: <u>Mill Tailings</u>                                     |
| Latitude: <u>N 46° 58' 00"</u>   | Primary Drainage: <u>Belt Creek</u>                                 |
| Longitude: <u>W 110° 43' 01"</u>   | USGS Code: <u>10030105</u>  |
| Land Status: <u>Private/Pubic</u>  | Secondary Drainage: <u>Carpenter Creek</u>                          |
| Quad: <u>Neihart</u>   | Date Investigated: <u>May 24 and 25, 1993</u>                       |
| Inspectors: <u>Tuesday, Babits, Clark, Belanger, Flammang, Lasher/Pierson</u>        | P.A. # <u>07-103</u>  |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |   |

- The total volume of mill tailings associated with this site was estimated at 111,000 cubic yards, contained in two impoundments (upper and lower). The following elements were elevated at least three times background:

|                              |                                 |
|------------------------------|---------------------------------|
| Arsenic: 34.5 to 139 mg/kg   | Barium: 663 to 2,820 mg/kg      |
| Cadmium: 12.4 to 34.2 mg/kg  | Cobalt: 21.5 mg/kg              |
| Copper: 1,950 to 3,740 mg/kg | Manganese: 2,100 to 6,870 mg/kg |
| Lead: 3,750 to 18,500 mg/kg  | Zinc: 1,790 to 2,990 mg/kg      |
- The tailings were poorly contained, and were actively eroding into Carpenter Creek from surface runoff and bank undercutting, and were only 25% vegetated. Tailings materials were observed washing into Carpenter Creek during a storm event.
- No waste rock or flowing adits were associated with this site.
- An observed release to surface water for arsenic, barium, and lead was documented with sediment samples. No exceedences of drinking water standards were documented. Aquatic life criteria exceedences for cadmium, copper, lead, and zinc (acute) and mercury, cadmium, copper, lead, and zinc (chronic) were documented at this site.
- A spring was located in the northeast corner of the lower pond and ponded up by the road. This water eventually crossed the lower tailings and discharged to Carpenter Creek.
- No hazardous structures or openings existed at the site, though several old cabins at the site were unsafe.



**Carpenter Creek Tailings PA# 07-103**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER-TUESDAY**  
**INVESTIGATION DATE: 6/24/93**

**SOLID MATRIX ANALYSES**

| Metals in soils |            | Results per dry weight basis |            |            |            |            |            |            |            |            |            |            |            |                 |
|-----------------|------------|------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| FIELD ID        | As (mg/Kg) | Ba (mg/Kg)                   | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 07-103-LT-1     | 61.4       | 927                          | 24.1       | 11         | 14.9 J     | 3450       | 42600      | 0.095 J    | 4720       | 31.9       | 7870       | 4.21 UJ    | 2370       | 1.16 U          |
| 07-103-LT-2     | 25.1       | 2820                         | 30.6       | 5.49       | 9.22 J     | 2740       | 28600      | 0.071 J    | 3950       | 24.9       | 4940       | 3.59 UJ    | 2150       | 1.072 U         |
| 07-103-SE-1     | 73         | 1100                         | 20.3       | 12.2       | 13.7 J     | 3440       | 43900      | 0.071 J    | 4090       | 30.7       | 9540       | 3.99 UJ    | 1790       | NR              |
| 07-103-SE-3     | 139        | 905                          | 34.2       | 21.5       | 11.5 J     | 3740       | 49500      | 0.062 J    | 4360       | 36.8       | 18500      | 4.06 UJ    | 1960       | NR              |
| 07-103-SE-4     | 46.6       | 737                          | 25.0       | 10.2       | 15.2 J     | 2670       | 38000      | 0.106 J    | 5030       | 34.7       | 6840       | 3.88 UJ    | 2090       | NR              |
| 07-103-SE-5     | 34.5       | 168                          | 12.4       | 8.72       | 9.27 J     | 2910       | 28000      | 0.045 J    | 2100       | 16.7       | 5100       | 3.33 UJ    | 1090       | NR              |
| 07-103-UT-1     | 69.8       | 663                          | 28.0       | 11.3       | 19.2       | 2850       | 47500      | 0.015 U    | 6830       | 45.8       | 4620       | 5.27 J     | 2990       | 1.194 U         |
| 07-103-UT-2     | 36.6       | 1200                         | 21.3       | 9.93       | 16.1       | 1950       | 40700      | 0.019 U    | 6870       | 45.4       | 3750       | 5.24 J     | 2050       | 1.231 U         |
| BACKGROUND      | 10.5       | 131                          | 1.4        | 6.83       | 22.2       | 26.1       | 20600      | 0.048 U    | 607        | 15.6       | 667        | 3.39 UJ    | 548        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 07-103-LT-1 | 1.21           | 37.8                           | 25.1                     | -13                              | 0.09             | 0.5              | 0.61             | 15.9                             | 9.16                             |
| 07-103-LT-2 | 0.5            | 15.6                           | 16.1                     | 0.43                             | 0.2              | 0.15             | 0.15             | 4.69                             | 11.4                             |
| 07-103-UT1  | 0.42           | 13.1                           | 23.4                     | 10.3                             | 0.07             | 0.05             | 0.30             | 1.56                             | 21.9                             |
| 07-103-UT2  | 0.57           | 17.8                           | 21.2                     | 3.40                             | 0.12             | 0.13             | 0.32             | 4.06                             | 17.1                             |

**WATER MATRIX ANALYSES**

| Metals in Water |      | Results in ug/L |      |        |        |        |     |         |     |        |      | HARDNESS CALC. |                |
|-----------------|------|-----------------|------|--------|--------|--------|-----|---------|-----|--------|------|----------------|----------------|
| FIELD ID        | As   | Ba              | Cd   | Co     | Cr     | Cu     | Fe  | Hg      | Mn  | Ni     | Pb   | Sb             | Zn(mg CaCO3/L) |
| 07-103-SW-1     | 2.6  | 18.6            | 4.13 | 5.99 U | 8.53 J | 62.9 J | 174 | 0.064 J | 243 | 8.78 U | 42   | 18.3 U         | 560            |
| 07-103-SW-3     | 2.17 | 18.3            | 4.5  | 5.99 U | 5.1 J  | 62.2 J | 226 | 0.15 J  | 249 | 8.78 U | 45.8 | 18.3 U         | 549            |
| 07-103-SW-4     | 2.58 | 14.9            | 4.4  | 5.99 U | 5 U    | 54.9 J | 127 | 0.088 J | 244 | 8.78 U | 24.8 | 18.3 U         | 539            |
| 07-103-SW-5     | 2.81 | 15.8            | 3.37 | 5.99 U | 6.67 J | 56.2 J | 148 | 0.083 J | 252 | 9.57   | 30.4 | 18.3 U         | 526            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Wet Chemistry**

**Results in mg/l**

| FIELD I.D.  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 07-103-SW-1 | 83                     | < 5.0    | 14      | < 0.05    | NR      |
| 07-103-SW-3 | 85                     | < 5.0    | 17      | < 0.05    | NR      |
| 07-103-SW-4 | 74                     | < 5.0    | 14      | < 0.05    | NR      |
| 07-103-SW-5 | 74                     | < 5.0    | 10      | < 0.05    | NR      |

**LEGEND**

LT1 - Composite of subsamples LT-1A, -2A, -3A, and -4A.  
 LT2 - Composite of subsamples LT-1D, -2D, 3C, and 4B.  
 SE1 - Just above confluence of Carpenter Creek with Snow Creek approximately 730 feet from SE1.  
 SE3 - At PPE of lower tailings pond in Carpenter Creek.  
 SE4 - At PPE of upper tailings pond in Carpenter Creek.  
 SE5 - Upgradient of upper tailings pond in Carpenter Creek.  
 UT1 - Composite of subsamples UT1B, 2A, and 3B.  
 UT2 - Composite of subsamples UT1D, 2C, and 3C.  
 BACKGROUND - From Silver Dyke Adit (07-135-SS-1).  
 SW1 - Above Snow Creek confluence in Carpenter Creek.  
 SW3 - Same as sample SE3.  
 SW4 - Same as sample SE4.  
 SW5 - Same as sample SE5.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Rochester</u>                      | County: <u>Cascade</u>                     |
| Legal Description: T <u>14N</u> R <u>8E</u>           | Section(s): <u>SE 1/4, SE 1/4, Sec. 29</u> |
| Mining District: <u>Neihart</u>                       | Mine Type: <u>Hardrock/Au, Ag, Zn, Pb</u>  |
| Latitude: <u>N 46° 56' 24"</u>                        | Primary Drainage: <u>Belt Creek</u>        |
| Longitude: <u>W 110° 43' 46"</u>                      | USGS Code: <u>10030105</u>                 |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Rock Creek</u>      |
| Quad: <u>Neihart</u>                                  | Date Investigated: <u>June 2, 1993</u>     |
| Inspectors: <u>Tuesday, Belanger, Lasher</u>          | P.A. # <u>07-110</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- No mill tailings were associated with this site.
- The volume of waste rock associated with this site was estimated to be 3,280 cubic yards. The following elements were elevated at least three times background:

|                             |                              |
|-----------------------------|------------------------------|
| Arsenic: 193J mg/kg         | Barium: 744J to 1,110J mg/kg |
| Cadmium: 7.3 to 136 mg/kg   | Chromium: 37.9J mg/kg        |
| Copper: 47.4J to 205J mg/kg | Iron: 38,800 to 40,900 mg/kg |
| Mercury: 0.65 mg/kg         | Nickel: 76.5 to 160 mg/kg    |
| Lead: 3,580 to 10,700 mg/kg | Antimony: 51.4J mg/kg        |
| Zinc: 2,060 to 29,700 mg/kg |                              |
- The waste rock dumps had only sparse vegetated.
- Rock Creek was flowing adjacent to WR-6 and undercutting the waste dump and formed an unstable highwall. No samples of Rock Creek were collected. The pH and specific conductance ranged from 5.77, and 330 umhos/cm upstream to 5.94 and, 420 umhos/cm downstream.
- No observed releases, exceedances of drinking water standards or aquatic life criteria were documented at this site.
- No discharging adits, springs or seeps were observed.
- Four hazardous openings existed at the site: partially caved shafts with steep sides.

**Rochester PA# 07-110**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUSEDAY**  
**INVESTIGATION DATE: 06/02/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 07-110-WR-5 | 193 J         | 1110 J        | 136.0         | 14.7          | 37.9 J        | 205 J         | 38800         | 0.65          | 27700         | 160           | 10700         | 51.4 J        | 29700         | NR                 |
| 07-110-WR-6 | 32.5 J        | 744 J         | 7.3           | 15.1          | 14.3 J        | 47.4 J        | 40900         | 0.354         | 13100         | 76.5          | 3580          | 4.11 J        | 2060          | NR                 |
| BACKGROUND  | 19 J          | 110           | 0.4 UJ        | 7.4           | 10.4          | 11            | 12000         | 0.142         | 320           | 10 J          | 138           | 3 UJ          | 115           | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID   | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|------------|----------------------|---|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 07-110-WR5 | 1.32                 | 41.2                                    | 141                           | 99.8                                      | 0.03                   | 0.47                   | 0.82                   | 14.7                                      | 126                                       |
| 07-110-WR6 | 0.74                 | 23.1                                    | 39.4                          | 16.3                                      | 0.22                   | 0.23                   | 0.29                   | 7.19                                      | 32.3                                      |

**LEGEND**

WR5 - Composite of subsamples WR5A, 5B, 5C, and 5D.  
WR6 - Composite of subsamples WR6A, 6B, and 6C.  
BACKGROUND - From the Maud S. Mine (07-129-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |  |
|--|--|
| Mine/Site Name: <u>Silver Belt</u>   | County: <u>Cascade</u>                     |
| Legal Description: T <u>14 N</u> R <u>8 E</u>  | Section(s): <u>NW 1/4, SW 1/4, Sec. 28</u> |
| Mining District: <u>Neihart</u>  | Mine Type: <u>Hardrock/Ag, Pb, Zn, Au</u>  |
| Latitude: <u>N 46° 56' 39"</u>   | Primary Drainage: <u>Belt Creek</u>        |
| Longitude: <u>W 110° 43' 15"</u>   | USGS Code: <u>10030105</u>                 |
| Land Status: <u>Private/Public</u>   | Secondary Drainage: <u>Rock Creek</u>      |
| Quad: <u>Neihart</u>   | Date Investigated: <u>July 30, 1993</u>    |
| Inspectors: <u>Babits, Flammang/Pierson</u>  | P.A. # <u>07-111</u>                       |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |  |

- There were no tailings at this site.
- The volume of uncovered waste rock on site was estimated to be approximately 9,005 cubic yards. The following were elevated at least three times background:

|                               |                                 |
|-------------------------------|---------------------------------|
| Arsenic: 500 to 581 mg/kg     | Cadmium: 35.3 J to 83.8J mg/kg  |
| Copper: 116J to 135J mg/kg    | Iron: 57,900 to 59,300 mg/kg    |
| Mercury: 0.645JX mg/kg        | Manganese: 2,620 to 3,080 mg/kg |
| Lead: 4,180 to 5,350 mg/kg    | Antimony 24J to 28J mg/kg       |
| Zinc: 9,500J to 18,300J mg/kg |                                 |
- One adit discharge was identified at the site; the pH measurement was 6.63. The MCL for cadmium and the acute and chronic aquatic life criteria for cadmium, copper, lead, and zinc were exceeded in the adit discharge. Also, the chronic aquatic life criteria for iron and mercury were exceeded in the adit discharge.
- Rock Creek flowed through waste rock located on site. Observed releases to Rock Creek were documented for cadmium, copper, mercury, manganese, and zinc. The MCL for cadmium and acute and chronic aquatic life criteria for cadmium and copper were exceeded in the downstream sample; these exceedances were directly attributable to the site.



**Silver Belt PA# 07-111**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/30/93**

| SOLID MATRIX ANALYSES                           |               |               |               |               |               |               |               |               |               |               |               |               |               |                    |
|---|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| Metals in soils<br>Results per dry weight basis |               |               |               |               |               |               |               |               |               |               |               |               |               |                    |
| FIELD ID  | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
| 07-111-SE-1                                     | 144 J         | 114 J         | 53.2 J        | 19.3          | 7.6 J         | 187 J         | 31900         | 0.143 JX      | 13200         | 27            | 2810          | 13 J          | 8060 J        | NR                 |
| 07-111-SE-2                                     | 28 J          | 258 J         | 10.4 J        | 13.3          | 29.8 J        | 50.9 J        | 28200         | 0.104 JX      | 1010          | 26            | 225           | 17 U          | 1650 J        | NR                 |
| 07-111-WR-1                                     | 581 J         | 105 J         | 35.3 J        | 13.1          | 29.8 J        | 116 J         | 59300         | 0.39 JX       | 3080          | 29            | 4180          | 24 J          | 9500 J        | NR                 |
| 07-111-WR-2                                     | 500 J         | 85.6 J        | 83.8 J        | 6             | 5.1 J         | 135 J         | 57900         | 0.645 JX      | 2620          | 5             | 5350          | 28 J          | 18300 J       | NR                 |
| BACKGROUND                                      | 19 J          | 110           | 0.4 UJ        | 7.4           | 10.4          | 11            | 12000         | 0.142         | 320           | 10 J          | 138           | 3 UJ          | 115           | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

| Acid/Base Accounting |                |                                |                         |                                  |                  |                  |                  |                                  |                                  |
|----------------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| FIELD ID             | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
| 07-111-WR-1          | 1.56           | 48.7                           | 5.19                    | -43.5                            | 0.89             | 0.21             | 0.46             | 6.56                             | -1.37                            |
| 07-111-WR-2          | 0.55           | 17.2                           | 2.45                    | -14.7                            | 0.27             | 0.02             | 0.26             | 0.62                             | 1.83                             |

| WATER MATRIX ANALYSES              |        |      |        |       |        |        |      |         |       |        |      |        |                 |                |
|------------------------------------|--------|------|--------|-------|--------|--------|------|---------|-------|--------|------|--------|-----------------|----------------|
| Metals in Water<br>Results in ug/L |        |      |        |       |        |        |      |         |       |        |      |        |                 |                |
| FIELD ID                           | As     | Ba   | Cd     | Co    | Cr     | Cu     | Fe   | Hg      | Mn    | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
| 07-111-GW-1                        | 4.99 J | 3.87 | 37.9   | 19.7  | 6.83 U | 28.2   | 1520 | 0.11 J  | 14100 | 48.6   | 231  | 30.7 U | 8930            | 68             |
| 07-111-SW-1                        | 2.1 J  | 19.8 | 13     | 9.7 U | 6.83 U | 10.1   | 22.7 | 0.14 J  | 462   | 12.7 U | 3.93 | 30.7 U | 3800            | 52.5           |
| 07-111-SW-2                        | 2.76 J | 34.1 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 32.8 | 0.038 U | 11.4  | 12.7 U | 1.54 | 30.7 U | 86.8            | 34             |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

| Wet Chemistry<br>Results in mg/l |                        |          |         |           |         |
|----------------------------------|------------------------|----------|---------|-----------|---------|
| FIELD ID                         | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
| 07-111-GW-1                      | 176                    | < 5.0    | 109     | 0.05      | NR      |
| 07-111-SW-1                      | 97                     | < 5.0    | 46      | < 0.05    | NR      |
| 07-111-SW-2                      | 76                     | < 5.0    | 6       | < 0.05    | NR      |

| LEGEND  |                    |
|---|--------------------|
| SE1 - 100 feet below waste rock dump 2 on Rock Creek. | SW1 - Same as SE1. |
| SE2 - Across from cabins above waste rock dump 2.     | SW2 - Same as SE2. |
| WR1 - Composite of subsamples WR1A, 1B, 1C, and 1D.   |                    |
| WR2 - Composite of subsamples WR2A and 2B.            |                    |
| BACKGROUND - From Maud S. Mine (07-129-SS-1).         |                    |

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |  |
|--|--|
| Mine/Site Name: <u>Fairplay</u>  | County: <u>Cascade</u>                     |
| Legal Description: T <u>14N</u> R <u>8E</u>  | Section(s): <u>SW 1/4, NW 1/4, Sec. 28</u> |
| Mining District: <u>Neihart</u>  | Mine Type: <u>Hardrock/Ag, Pb, Zn, Au</u>  |
| Latitude: <u>N 46° 56' 44"</u>   | Primary Drainage: <u>Belt Creek</u>        |
| Longitude: <u>W 110° 43' 10"</u>   | USGS Code: <u>10030105</u>                 |
| Land Status: <u>Private/Public</u>   | Secondary Drainage: <u>Rock Creek</u>      |
| Quad: <u>Neihart</u>   | Date Investigated: <u>July 30, 1993</u>    |
| Inspectors: <u>Babits, Flammang/Pierson</u>  | P.A. # <u>07-112</u>                       |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |  |

- There were no tailings at this site.
- An estimated 2,010 cubic yards of uncovered waste rock were located at this site. The following elements were elevated at least three times background:

|                       |                        |
|-----------------------|------------------------|
| Arsenic: 257J mg/kg   | Cadmium: 22.9J mg/kg   |
| Copper: 287J mg/kg    | Iron: 40,500 mg/kg     |
| Mercury: 1.02JX mg/kg | Manganese: 1,140 mg/kg |
| Lead: 18,400 mg/kg    | Antimony: 20J mg/kg    |
| Zinc: 6,260 mg/kg     |                        |
- One discharging adit was identified at the site; the pH measurement was 6.09. The MCL for cadmium and the acute and chronic aquatic life criteria for cadmium, copper, lead, and zinc were exceeded in the adit discharge. Additionally, the chronic aquatic life criteria for iron was exceeded in the adit discharge.
- Waste rock was located approximately 40 feet from an unnamed tributary to Rock Creek. No MCL/MCLG or acute or chronic aquatic life criteria exceedances were attributed to the site.
- An observed release to the unnamed tributary to Rock Creek (sediment) was documented for mercury.
- There were no hazardous openings or structures identified at the site.

**Fairplay PA# 07-112**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/30/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 07-112-SE-1 | 21 J       | 230 J      | 3.5 J      | 22.6       | 48.9 J     | 36.6 J     | 43600      | 0.026 JX   | 2680       | 26         | 455        | 7 U        | 763 J      | NR              |
| 07-111-SE-2 | 28 J       | 258 J      | 10.4 J     | 13.3       | 29.8 J     | 50.9 J     | 28200      | 0.104 JX   | 1010       | 26         | 225        | 17 U       | 1650 J     | NR              |
| 07-112-WR-1 | 257 J      | 44.2 J     | 22.9 J     | 3.5        | 2.5 J      | 287 J      | 40500      | 1.02 JX    | 1140       | 4          | 18400      | 20 J       | 6260 J     | NR              |
| BACKGROUND  | 19 J       | 110        | 0.4 UJ     | 7.4        | 10.4       | 11         | 12000      | 0.142      | 320        | 10 J       | 138        | 3 UJ       | 115        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 07-112-WR-1 | 2.48           | 77.5                           | 47.4                     | -30.1                            | 0.44             | 0.98             | 1.06             | 30.6                             | 16.8                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba     | Cd     | Co    | Cr     | Cu     | Fe     | Hg      | Mn     | Ni     | Pb      | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|--------|--------|-------|--------|--------|--------|---------|--------|--------|---------|--------|-----------------|----------------|
| 07-112-GW-1 | 15.2 J | 9.7    | 22.9   | 11.5  | 6.83 U | 58.9   | 8010   | 0.038 U | 2280   | 12.7 U | 92.7    | 30.7 U | 5350            | 74.1           |
| 07-112-SW-1 | 1.89 J | 33.7   | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 37.8   | 0.066 J | 7.9    | 12.7 U | 0.88    | 30.7 U | 20.5            | 33.9           |
| 07-112-SW-2 | 2.61 J | 2.01 U | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 11.8 U | 0.1 J   | 4.08 U | 12.7 U | 0.72 UJ | 30.7 U | 7.57 U          | 0.1            |
| 07-111-SW-2 | 2.76 J | 34.1   | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 32.8   | 0.038 U | 11.4   | 12.7 U | 1.54    | 30.7 U | 86.8            | 34             |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID.   | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 07-112-GW-1 | 158                    | < 5.0    | 88      | < 0.05    | NR      |
| 07-112-SW-1 | 67                     | < 5.0    | 5       | < 0.05    | NR      |
| 07-112-SW-2 | NR                     | NR       | NR      | NR        | NR      |
| 07-111-SW-2 | 76                     | < 5.0    | 6       | < 0.05    | NR      |

**LEGEND**

07-111-SE2 - Dongradient sample (From Silver Belt).  
SE1 - Across from dump where stream first appears.  
WR1 - A composite of subsamples WR1A and B (2/3 A and 1/3 B).  
BACKGROUND - From Maud S. Mine (07-129-SS-1).

GW1 - Adit discharge from adit #1.  
07-111-SW2 - Same as 07-111-SE2 sample.  
SW1 - Same as SE1.  
SW2 - QA Blank.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Atlantus</u>                       | County: <u>Cascade</u>                      |
| Legal Description: T <u>14N</u> R <u>8E</u>           | Section(s): <u>SE 1/4, SE 1/4, Sec. 29</u>  |
| Mining District: <u>Neihart</u>                       | Mine Type: <u>Hardrock/Au, Ag, Pb, Zn</u>   |
| Latitude: <u>N 46° 56' 14"</u>                        | Primary Drainage: <u>Belt Creek</u>         |
| Longitude: <u>W 110° 43' 44"</u>                      | USGS Code: <u>10030105</u>                  |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Compromise Gulch</u> |
| Quad: <u>Neihart</u>                                  | Date Investigated: <u>June 2, 1993</u>      |
| Inspectors: <u>Tuesday, Belanger, Lasher</u>          | P.A. # <u>07-113</u>                        |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be 55 cubic yards. The following elements were elevated at least three times background (using XRF data):

|                              |                                   |
|------------------------------|-----------------------------------|
| Iron: 36,694 to 44,266 mg/kg | Manganese: 13,114 to 20,804 mg/kg |
| Lead: 3,681 to 4,363 mg/kg   | Zinc: 1,336 to 1,836 mg/kg        |
- No adit discharges, seeps or springs were observed. The nearest surface water was Compromise Gulch, 500 feet to the south.
- No observed releases or exceedences of drinking water standards or aquatic life criteria were documented during this investigation.
- One very hazardous mine opening was on site, a 30' deep, partially caved shaft with vertical sides.





**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |   |
|--|---|
| Mine/Site Name: <u>Stallabrass</u>   | County: <u>Cascade</u>                                    |
| Legal Description: <u>T 13N R 8E</u>   | Section(s): <u>SW 1/4, NW 1/4, Sec. 4</u>                 |
| Mining District: <u>Neihart</u>  | Mine Type: <u>Hardrock/Au (no significant production)</u> |
| Latitude: <u>N 46° 55' 11"</u>   | Primary Drainage: <u>Belt Creek</u>                       |
| Longitude: <u>W 110° 43' 24"</u>   | USGS Code: <u>10030105</u>                                |
| Land Status: <u>Private/Public</u>   | Secondary Drainage: <u>Belt Creek</u>                     |
| Quad: <u>Neihart</u>   | Date Investigated: <u>July 30, 1993</u>                   |
| Inspectors: <u>Bullock, Clark/Pierson</u>  | P.A. # <u>07-120</u>                                      |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |   |

- Neihart tailings were hauled to this site during highway construction in the late 1970's for driveway cover. The material was not used and was presently stock piled adjacent to the MDT Maintenance facility. The volume of mill tailings was estimated to be 50 cubic yards. The following elements were elevated at least three times background:

|                      |                        |
|----------------------|------------------------|
| Arsenic: 181J mg/kg  | Manganese: 7,960 mg/kg |
| Barium: 3,000J mg/kg | Lead: 7,320 mg/kg      |
| Cadmium: 17.9J mg/kg | Antimony: 14J mg/kg    |
| Copper: 157J mg/kg   | Zinc: 4,570J mg/kg     |
- The volume of waste rock associated with this site was estimated to be 5,458 cubic yards. The following elements were elevated at least three time background:

|                      |                       |
|----------------------|-----------------------|
| Arsenic: 165J mg/kg  | Mercury: 3.54JX mg/kg |
| Barium: 2,880J mg/kg | Lead: 1,800 mg/kg     |
| Cadmium: 2.4J mg/kg  | Antimony: 27J mg/kg   |
| Copper: 76.1J mg/kg  | Zinc: 673J mg/kg      |
| Iron: 36,700 mg/kg   |                       |
- There were no discharging mine openings, seeps or springs identified at this site.
- No domestic groundwater wells were present on this site. The residents on this site used water directly from Belt Creek instead of groundwater.
- There were no direct runoff pathways between this site and Belt Creek, located approximately 150 yards from the base of the lower waste rock dump.
- There were 3 adits identified at this site, all classified as hazardous mine openings.

**Stallabross Pa# 07-120**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/30/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 07-120-TP-1 | 181 J         | 3000 J        | 17.9 J        | 2.3 U         | 9.3 J         | 157 J         | 30900         | 0.116 JX      | 7960          | 12            | 7320          | 14 J          | 4570 J        | NR                 |
| 07-120-WR-1 | 165 J         | 2880 J        | 2.4 J         | 5.9           | 11.5 J        | 76.1 J        | 36700         | 3.54 JX       | 549           | 21            | 1800          | 27 J          | 673 J         | NR                 |
| BACKGROUND  | 19 J          | 110           | 0.4 UJ        | 7.4           | 10.4          | 11            | 12000         | 0.142         | 320           | 10 J          | 138           | 3 UJ          | 115           | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID       | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|----------------|----------------------|---|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 07-120-TP-1    | 0.74                 | 23.1                                    | 10.1                          | -13.0                                     | <0.01                  | 0.39                   | 0.38                   | 12.2                                      | -2.05                                     |
| 07-120-TP-1DUP | 0.72                 | 22.5                                    | 10.9                          | -11.6                                     | <0.01                  | 0.38                   | 0.37                   | 11.9                                      | -0.98                                     |
| 07-120-WR-1    | 0.72                 | 22.5                                    | 14.5                          | -8.02                                     | 0.35                   | 0.08                   | 0.29                   | 2.50                                      | 12.0                                      |

**LEGEND**

TP1 - Pile of Neihart Tailings at MDT maintenance facility.  
WR1 - Composite from unvegetated areas on dump.  
BACKGROUND - From the Maud S. Mine (07-129-SS-1).  
TP1DUP - Duplicate of the 07-120-TP-1 sample.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Dacotah  
Legal Description: T 14N R 8E  
Mining District: Neihart  
Latitude: N 46° 56' 45"  
Longitude: W 110° 43' 24"  
Land Status: Private/Public  
Quad: Neihart  
Inspectors: Bullock, Babits, Flammang,  
Lasher, Clark/Pierson  
Organization: Pioneer Technical Services, Inc.

County: Cascade  
Section(s): NW 1/4, SW 1/4, Sec. 28  
Mine Type: Hardrock/Ag, Pb, Zn  
Primary Drainage: Belt Creek  
USGS Code: 10030105  
Secondary Drainage: Rock Creek  
Date Investigated: June 8, 1993  
P.A. # 07-121

- There were no tailings on site.
- There were approximately 10,015 cubic yards of uncovered waste rock on site. The following were elevated at least three times background:

|                            |                                   |
|----------------------------|-----------------------------------|
| Arsenic: 83 to 255J mg/kg  | Cadmium: 9.3J to 40.1 mg/kg       |
| Copper: 66.2J to 129 mg/kg | Iron: 36,300 to 67,500 mg/kg      |
| Mercury: 0.793J mg/kg      | Manganese: 2,550 to 12,800J mg/kg |
| Nickel: 84J mg/kg          | Lead: 1,780 to 21,800 mg/kg       |
| Antimony: 26J mg/kg        | Zinc: 3,110J to 10,200 mg/kg      |
- There was one discharging adit on site which entered Belt Creek. A sample of the discharge revealed a pH of 2.38. MCLs for cadmium, nickel, and antimony and acute and chronic aquatic life criteria were exceeded for cadmium and zinc in the adit discharge. Additionally, chronic aquatic life criteria were exceeded for iron, mercury copper, lead, and nickel.
- The Belt Creek flowed immediately adjacent to the site. Observed releases to Belt Creek were documented for cadmium, copper, iron, manganese, nickel, lead, and zinc. The MCL for nickel was exceeded in the downstream sample, which was directly attributable to the site. Additionally, chronic aquatic life criteria were exceeded for iron and copper in the downstream sample, again attributable to the site.
- There was one open adit, numerous hazardous structures, and highwalls on site.



**Dacotah PA# 07-121**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 06/08/93**

| SOLID MATRIX ANALYSES   |                |                                |                         |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
|---|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|------------|------------|------------|------------|-----------------|
| Metals in soils<br>Results per dry weight basis   |                |                                |                         |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
| FIELD ID  | As (mg/Kg)     | Ba (mg/Kg)                     | Cd (mg/Kg)              | Co (mg/Kg)                       | Cr (mg/Kg)       | Cu (mg/Kg)       | Fe (mg/Kg)       | Hg (mg/Kg)                       | Mn (mg/Kg)                       | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 07-121-SE-1   | 38             | 98.9                           | 63.2 J                  | 13.6 J                           | 33.4             | 541 J            | 9170             | 0.178 J                          | 7920 J                           | 92 J       | 398        | 14 U       | 11300 J    | NR              |
| 07-121-SE-2   | 126            | 133                            | 3 J                     | 6.1 J                            | 12.1             | 26.6 J           | 65200            | 0.063 J                          | 1000 J                           | 12 J       | 1710       | 4 U        | 1270 J     | NR              |
| 07-121-WR-1   | 105            | 56.1                           | 14.9 J                  | 17.8 J                           | 7.5              | 78.8 J           | 36300            | 0.105 J                          | 12800 J                          | 84 J       | 1780       | 4 U        | 4650 J     | NR              |
| 07-121-WR-5   | 83             | 144                            | 9.3 J                   | 2 J                              | 10.3             | 66.2 J           | 67500            | 0.793 J                          | 379 J                            | 4 J        | 7510       | 4 U        | 3110 J     | NR              |
| 07-121-WR-6   | 255 J          | 205                            | 40.1                    | 5.6                              | 5.3              | 129              | 40000            | 0.416                            | 2550                             | 20 J       | 21800      | 26 J       | 10200      | NR              |
| BACKGROUND  | 19 J           | 110                            | 0.4 UJ                  | 7.4                              | 10.4             | 11               | 12000            | 0.142                            | 320                              | 10 J       | 138        | 3 UJ       | 115        | NR              |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                |                                |                         |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
| Acid/Base Accounting  |                |                                |                         |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
| FIELD ID  | TOTAL SULFUR % | TOTAL SULFUR ACID BASE 1/1000t | NEUTRAL POTENT. 1/1000t | SULFUR ACID BASE POTENT. 1/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE 1/1000t | SULFUR ACID BASE POTENT. 1/1000t |            |            |            |            |                 |
| 07-121-WR-1   | 3.25           | 102                            | 37.8                    | -64                              | 1.13             | 0.56             | 1.56             | 17.5                             | 20.3                             |            |            |            |            |                 |
| 07-121-WR-5   | 2.37           | 74                             | 6.28                    | -68                              | 1.87             | 0.03             | 0.47             | 0.94                             | 5.34                             |            |            |            |            |                 |
| 07-121-WR-6DUP  | 1.65           | 51.5                           | 7.7                     | -44                              | 0.56             | 0.29             | 0.8              | 9.06                             | -1.36                            |            |            |            |            |                 |
| 07-121-WR-6   | 1.63           | 50.9                           | 7.56                    | -43                              | 0.54             | 0.27             | 0.82             | 8.43                             | -0.88                            |            |            |            |            |                 |

| WATER MATRIX ANALYSES   |                        |          |         |           |         |      |       |       |        |      |      |      |                 |                |
|---|------------------------|----------|---------|-----------|---------|------|-------|-------|--------|------|------|------|-----------------|----------------|
| Metals in Water<br>Results in ug/L  |                        |          |         |           |         |      |       |       |        |      |      |      |                 |                |
| FIELD ID  | As                     | Ba       | Cd      | Co        | Cr      | Cu   | Fe    | Hg    | Mn     | Ni   | Pb   | Sb   | Zn (mg CaCO3/L) | HARDNESS CALC. |
| 07-121-GW-1   | 5.13                   | 2.24 U   | 420     | 196       | 21.2    | 90.1 | 52600 | 0.047 | 152000 | 951  | 216  | 220  | 172000          | 785            |
| 07-121-SW-1   | 1.61 U                 | 17.7     | 10.7    | 5.99 U    | 6.67    | 5.07 | 95.9  | 0.078 | 231    | 12.6 | 2.52 | 21.8 | 3060            | 51.9           |
| 07-121-SW-2   | 1.96                   | 15       | 65.9    | 14        | 5.33    | 21.4 | 1580  | 0.11  | 16400  | 124  | 48   | 43.9 | 22600           | 141            |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                        |          |         |           |         |      |       |       |        |      |      |      |                 |                |
| Wet Chemistry<br>Results in mg/l  |                        |          |         |           |         |      |       |       |        |      |      |      |                 |                |
| FIELD ID  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |      |       |       |        |      |      |      |                 |                |
| 07-121-GW-1   | 2330                   | < 5.0    | 1400    | < 0.05    | NR      |      |       |       |        |      |      |      |                 |                |
| 07-121-SW-1   | 96                     | < 5.0    | 53      | < 0.05    | NR      |      |       |       |        |      |      |      |                 |                |
| 07-121-SW-2   | 340                    | < 5.0    | 170     | 0.06      | NR      |      |       |       |        |      |      |      |                 |                |

**LEGEND**

SE1 - Ugradient of Dacotah, downgradient of Fairplay.  
 SE2 - Sample of Rock Creek at base of waste rock dump 1.  
 WR1 - Composite of subsamples WR1A, 1B, 1C, and 2.  
 WR5 - Composite of subsamples WR3, 5A, 5B, 9A, and 9B.  
 WR6 - Composite of subsamples WR6, 7, and 8.  
 BACKGROUND - From the Maud S. Mine (07-129-SS-1).

GW1 - Discharge from adit #1.  
 SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Maud S.</u>                        | County: <u>Cascade</u>                     |
| Legal Description: T <u>14N</u> R <u>8E</u>           | Section(s): <u>SW 1/4, SW 1/4, Sec. 28</u> |
| Mining District: <u>Neihart</u>                       | Mine Type: <u>Hardrock/Ag, Pb, Zn</u>      |
| Latitude: <u>N 46° 56' 25"</u>                        | Primary Drainage: <u>Belt Creek</u>        |
| Longitude: <u>W 110° 43' 18"</u>                      | USGS Code: <u>10030105</u>                 |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Rock Creek</u>      |
| Quad: <u>Neihart</u>                                  | Date Investigated: <u>June 9, 1993</u>     |
| Inspectors: <u>Babits, Flammang</u>                   | P.A. # <u>07-129</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no tailings on site.
- There were approximately 1,800 cubic yards of uncovered waste rock on site. The following were elevated at least three times background:

|                        |                     |
|------------------------|---------------------|
| Arsenic: 1,380J mg/kg  | Barium: 526 mg/kg   |
| Cadmium: 35.9 mg/kg    | Copper: 159 mg/kg   |
| Iron: 55,600 mg/kg     | Mercury: 1.11 mg/kg |
| Manganese: 8,290 mg/kg | Nickel: 55J mg/kg   |
| Lead: 7,880 mg/kg      | Lead: 7,880 mg/kg   |
| Antimony: 18J mg/kg    | Zinc: 5,610 mg/kg   |
- One adit was identified on site, which held water but was not discharging. The pH of the adit discharge was 6.51. MCLs for cadmium and antimony and acute and chronic aquatic life criteria for cadmium, copper, lead and zinc were exceeded in the sample.
- There was no surface water on site. The nearest surface water was Rock Creek located approximately 0.5 miles away. No surface water or sediment samples were collected.

**Maud S. PA# 07-129**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 06/08/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 07-129-WR-1 | 1380 J        | 526           | 35.9          | 17.9          | 27            | 159           | 55600         | 1.11          | 8290          | 55 J          | 7880          | 18 J          | 5610          | NR                 |
| BACKGROUND  | 19 J          | 110           | 0.4 UJ        | 7.4           | 10.4          | 11            | 12000         | 0.142         | 320           | 10 J          | 138           | 3 UJ          | 115           | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 07-129-WR-1 | 1.14              | 44                                   | 7.25                          | -37                                       | 1.07                   | 0.04                   | 0.3                    | 1.25                                      | 6   |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd   | Co     | Cr   | Cu   | Fe   | Hg   | Mn   | Ni   | Pb  | Sb   | HARDNESS<br>CALC.<br>Zn (mg CaCO3/L) |
|-------------|--------|------|------|--------|------|------|------|------|------|------|-----|------|--------------------------------------|
| 07-129-GW-1 | 1.61 U | 19.5 | 42.6 | 5.99 U | 5 U  | 22   | 89   | 0.14 | 2730 | 31.9 | 228 | 28.2 | 6260 31                              |
| 07-129-GW-2 | 1.74   | 19.2 | 39.5 | 5.99 U | 7.67 | 21.9 | 63.9 | 0.15 | 2710 | 33.3 | 222 | 30.2 | 6360 31.7                            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED<br>SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|---------------------------|----------|---------|-----------|---------|
| 07-129-GW-1 | 64                        | < 5.0    | 43      | 0.11      | NR      |
| 07-129-GW-2 | 51                        | < 5.0    | 40      | 0.12      | NR      |

**LEGEND**

WR1 - Composite of subsamples WR1A, 1B, and 1C.  
BACKGROUND - Approx. 150-200 feet above adit.  
From Maud S. Mine (07-129-SS-1).

GW1 - Filled adit.  
GW2 - Duplicate of sample 07-129-GW-1.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Neihart Tailings  
Legal Description: T 14N R 8E  
Mining District: Neihart  
Latitude: N 46° 56' 30"  
Longitude: W 110° 44' 40"  
Land Status: Private/Public  
Quad: Neihart  
Inspectors: Bullock, Flammang, Clark  
Organization: Pioneer Technical Services, Inc.

County: Cascade  
Section(s): SW 1/4, SW 1/4, Sec. 29  
Mine Type: Mill Tailings Pond  
Primary Drainage: Belt Creek  
USGS Code: 10030105  
Secondary Drainage: Belt Creek  
Date Investigated: June 2, 1993  
P.A. # 07-134

- There were approximately 23,000 cubic yards of tailings associated with this site. The following elements were elevated at least three times background:  
Arsenic: 190 to 284 mg/kg                      Cadmium: 47.4 to 63.1 mg/kg  
Lead: 37,400 mg/kg                              Antimony: 10.1J to 17.4J mg/kg  
Zinc: 10,400 to 14,000 mg/kg
- There was no waste rock associated with this site.
- There were no discharging adits or shafts associated with this site.
- Belt Creek flowed between the tailings impoundment and U.S. Highway 89. The northeastern side of the tailings impoundment was heavily riprapped during a highway reconstruction project in the 1970's. A run-on diversion ditch, discharged into a small wetlands and then into Belt Creek which encircled the southern end of this site. A sample collected from the wetlands discharge did not exceed any MCL/MCLGs, but did exceed acute aquatic life criteria for cadmium and zinc, as well as chronic aquatic life criteria for cadmium, copper, lead, and zinc. Surface water samples were not collected in Belt Creek due to dilution effects from very high flowrates. Stream sediment samples from Belt Creek documented an observed release of arsenic, directly attributable to this site.
- One residence was located adjacent to this site, but did not appear to have been recently occupied.



**Nelhart Tailings PA# 07-134**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/02/93**

## SOLID MATRIX ANALYSES

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID      | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 07-134-SE-1   | 27.2          | 2440          | 93.1          | 11.5          | 15.5          | 67.7          | 17100         | 0.105 U       | 71500         | 488           | 1060          | 26.2 J        | 22800         | 2.277              |
| 07-134-SE-2   | 8             | 224           | 1.0           | 9.33          | 18.8          | 14.1          | 18400         | 0.083         | 865           | 26.9          | 327           | 3.93 UJ       | 528           | 1.289 U            |
| 07-134-SE-3   | 29.2          | 600           | 3.8           | 9.02          | 16            | 29.8          | 20100         | 0.05 U        | 2240          | 29.7          | 792           | 2.87 UJ       | 1170          | 1.227 U            |
| 07-134-TP-1-1 | 190           | 1630          | 47.4          | 3.96          | 7.31          | 223           | 33100         | 0.118         | 11100         | 63.4          | 10100         | 10.8 J        | 11400         | 1.213 U            |
| 07-134-TP-1-2 | 284           | 984           | 63.1          | 17.8          | 15.3          | 371           | 38300         | 0.121         | 20700         | 151           | 11400         | 17.4 J        | 14000         | 1.283 U            |
| 07-134-TP-2   | 234           | 38.7          | 40.7          | 5.4           | 4.22          | 62.7          | 53600         | 0.061 U       | 707           | 9.14          | 37400         | 10.1 J        | 10400         | 1.2 U              |
| BACKGROUND    | 53.3          | 828           | 15.3          | 11.6          | 72.7          | 50.1          | 30600         | 0.051 U       | 10400         | 91.5          | 5110          | 2.99 UJ       | 3530          | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

### Acid/Base Accounting

| FIELD ID        | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-----------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 07-134-TP1-1    | 1.64           | 51.2                           | 17.7                     | -34                              | 0.56             | 0.55             | 0.53             | 17.2                             | 0.54                             |
| 07-134-TP1-2DUP | 3.39           | 106                            | 26.5                     | -79                              | 0.15             | 2.07             | 1.17             | 64.7                             | -38.2                            |
| 07-134-TP1-2    | 3.37           | 105                            | 26.3                     | -79                              | 0.16             | 2.04             | 1.17             | 63.7                             | -37.4                            |
| 07-134-TP-2     | 4.94           | 154                            | -9.1                     | -163                             | 2.44             | 0.86             | 1.64             | 26.9                             | -35.9                            |
| 07-134-TP-2DUP  | 4.96           | 155                            | -9.3                     | -164                             | 2.45             | 0.88             | 1.63             | 27.5                             | -36.8                            |

## WATER MATRIX ANALYSES

**Metals in Water**  
**Results in ug/L**

| FIELD ID    | Results in ug/L |      |    |        |     |       |     |         |     |    |      |        | HARDNESS CALC.<br>Zn (mg CaCO3/L) |      |
|-------------|-----------------|------|----|--------|-----|-------|-----|---------|-----|----|------|--------|-----------------------------------|------|
|             | As              | Ba   | Cd | Co     | Cr  | Cu    | Fe  | Hg      | Mn  | Ni | Pb   | Sb     |                                   |      |
| 07-134-SW-1 | 0.98 U          | 41.6 | 3  | 5.99 U | 5 U | 8.9 J | 223 | 0.038 U | 660 | 16 | 12.1 | 18.3 U | 1580 JX                           | 57.3 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Wet Chemistry  
Results in mg/l**

| FIELD<br>I.D. | TOTAL<br>DISSOLVED<br>SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|---------------|------------------------------|----------|---------|-----------|---------|
| 07-134-SW-1   | 86                           | < 5.0    | 28      | < 0.05    | 0.01    |

### LEGEND

SE1 - Same as sample SW1.

SE2 - Upgradient Belt Creek Tailings.

SE3 - Downgradient of Belt Creek Tailings.

TP1-1 - Composite of oxidized zone; from holes 2-5 in tailings pond 1.

TP1-2 - Composite of TP2-1all and TP2-2all.

TP2 - Composite of reduced zone; from holes 2-5 in tailings pond 1.

BACKGROUND - From Compromise (07-1000-SS-1).

TP1-2DUP - Duplicate of sample 07-134-TP1-2.

TP2DUP - Duplicate of sample 07-134-TP-2.

SW1 - Outlet of Belt Creek of Belt Creek of settling pond associated with diversion ditch.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Silver Dyke Adit</u>               | County: <u>Cascade</u>                     |
| Legal Description: <u>T 14N R 8E</u>                  | Section(s): <u>SE 1/4, SW 1/4, Sec. 10</u> |
| Mining District: <u>Neihart</u>                       | Mine Type: <u>Hardrock / Ag, Pb, Zn</u>    |
| Latitude: <u>N 46° 58' 57"</u>                        | Primary Drainage: <u>Belt Creek</u>        |
| Longitude: <u>W 110° 41' 48"</u>                      | USGS Code: <u>10030105</u>                 |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Squaw Creek</u>     |
| Quad: <u>Neihart</u>                                  | Date Investigated: <u>June 1, 1993</u>     |
| Inspectors: <u>Tuesday, Belanger, Lasher</u>          | P.A. # <u>07-135</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be 12,100 cubic yards. The following elements were elevated at least three times background:

|                              |                             |
|------------------------------|-----------------------------|
| Arsenic: 124 to 217 mg/kg    | Cadmium: 48.6 to 72.7 mg/kg |
| Copper: 2,530 to 3,330 mg/kg | Iron: 80,900 mg/kg          |
| Mercury: 0.66 to 1.35 mg/kg  | Manganese: 4,040 mg/kg      |
| Lead: 16,400 to 31,800 mg/kg | Zinc: 6,050 to 7,050 mg/kg  |
- The waste rock dumps were unvegetated.
- One discharging adit had a significant flow (1 cfs). The adit water (SW-1) had a pH of 5.12, a high specific conductance of 2,450 us/cm, and exceeded drinking water standards for cadmium, copper, nickel, and antimony; aquatic life criteria for lead, mercury, cadmium, copper, lead, and zinc (chronic) and cadmium, copper, and zinc (acute) were exceeded in the adit discharge.
- The discharge flowed over the waste rock at the site and was the source of water in Squaw Creek. No observed releases were documented due to the lack of an upstream sample; however, downstream sediment data was more than three times background soil data for manganese, lead, and zinc. Exceedances of drinking water standards were documented in Squaw Creek for cadmium, copper, nickel, and antimony. Aquatic life criteria for lead, mercury, cadmium, copper, lead, and zinc (chronic) and cadmium, copper, and zinc (acute) were exceeded downstream in Squaw Creek. No seeps or springs were observed.
- One hazardous opening existed on-site: the glory hole on the hilltop above the adit had dangerously steep sides and the DSL erected fence was down in several places.

**Silver Dyke Adit PA# 07-135**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 06/01/93**

| SOLID MATRIX ANALYSES   |                   |                                      |                                |   |                        |                        |                        |   |   |               |               |               |               |                    |
|---|-------------------|--------------------------------------|--------------------------------|---|------------------------|------------------------|------------------------|---|---|---------------|---------------|---------------|---------------|--------------------|
| FIELD ID  | Metals in soils   |                                      | Results per dry weight basis   |   |                        |                        |                        |   |   |               |               |               |               |                    |
|   | As<br>(mg/Kg)     | Ba<br>(mg/Kg)                        | Cd<br>(mg/Kg)                  | Co<br>(mg/Kg)                             | Cr<br>(mg/Kg)          | Cu<br>(mg/Kg)          | Fe<br>(mg/Kg)          | Hg<br>(mg/Kg)                             | Mn<br>(mg/Kg)                             | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
| 07-135-SE-2   | 105               | 164                                  | 50.4                           | 11.2                                      | 10.3                   | 1500                   | 36500                  | 0.28                                      | 1680                                      | 13.8          | 15000         | 4.05 UJ       | 6580          | NR                 |
| 07-135-SE-3   | 33.9              | 70.7                                 | 5.4                            | 11.2                                      | 17.5                   | 933                    | 23700                  | 0.062                                     | 2230                                      | 17            | 2460          | 3.07 UJ       | 842           | NR                 |
| 07-135-SE-4   | 31.4              | 49.5                                 | 9.5                            | 14.6                                      | 14.2                   | 875                    | 24200                  | 0.062 U                                   | 1920                                      | 14.9          | 1960          | 3.22 UJ       | 1330          | NR                 |
| 07-135-WR-1   | 124               | 198                                  | 72.7                           | 6.9                                       | 10.6                   | 3330                   | 60300                  | 1.35                                      | 1460                                      | 12.3          | 31800         | 5.8 J         | 7050          | NR                 |
| 07-135-WR-2   | 217               | 237                                  | 48.6                           | 19  | 11.2                   | 2530                   | 80900                  | 0.66                                      | 4040                                      | 29.6          | 16400         | 2.8 UJ        | 6050          | NR                 |
| BACKGROUND  | 10.5              | 131                                  | 1.4                            | 6.83                                      | 22.2                   | 26.1                   | 20600                  | 0.048 U                                   | 607                                       | 15.6          | 667           | 3.39 UJ       | 548           | NR                 |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                   |                                      |                                |   |                        |                        |                        |   |   |               |               |               |               |                    |
| Acid/Base Accounting  |                   |                                      |                                |   |                        |                        |                        |   |   |               |               |               |               |                    |
| FIELD ID  | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL.<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |               |               |               |               |                    |
| 07-135-WR1  | 1.98              | 61.9                                 | -0.4                           | -62                                       | 0.9                    | 0.14                   | 0.94                   | 4.37                                      | -4.78                                     |               |               |               |               |                    |
| 07-135-WR2  | 1.97              | 61.5                                 | 1.04                           | -61                                       | 0.94                   | 0.22                   | 0.81                   | 6.87                                      | -5.84                                     |               |               |               |               |                    |

| WATER MATRIX ANALYSES   |                           |          |                 |           |         |      |         |       |           |        |        |        |                 |                   |
|---|---------------------------|----------|-----------------|-----------|---------|------|---------|-------|-----------|--------|--------|--------|-----------------|-------------------|
| FIELD ID  | Metals in Water           |          | Results in ug/L |           |         |      |         |       |           |        |        |        |                 |                   |
|   | As                        | Ba       | Cd              | Co        | Cr      | Cu   | Fe      | Hg    | Mn        | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS<br>CALC. |
| 07-135-GW-1   | 2.5                       | 29.3     | 2.55 U          | 5.99 U    | 5 U     | 12.3 | 173 J   | 0.150 | 75.9 JX   | 8.78 U | 5.24 J | 18.3 U | 497             | 83.1              |
| 07-135-GW-2   | 2.84                      | 29.4     | 2.55 U          | 5.99 U    | 5 U     | 25.3 | 308 J   | 0.079 | 204 JX    | 8.78 U | 4.76 J | 18.3 U | 1350            | 83.6              |
| 07-135-SW-1   | 4.88                      | 2.24 U   | 986 J           | 260       | 22.7    | 8950 | 37400 J | 0.150 | 128000 JX | 878    | 826 J  | 194    | 148000          | 1320              |
| 07-135-SW-2   | 7.12                      | 10.6     | 838 J           | 208       | 18      | 9440 | 21900 J | 0.120 | 109000 JX | 738    | 1400 J | 147    | 120000          | 1090              |
| 07-135-SW-3   | 4.37                      | 16.2     | 339 J           | 69        | 5 U     | 4220 | 1540 J  | 0.140 | 43100 JX  | 310    | 568 J  | 40.6   | 56900           | 495               |
| 07-135-SW-4   | 4.79                      | 21.5     | 223 J           | 46        | 5 U     | 2700 | 1290 J  | 0.160 | 26000 JX  | 201    | 343 J  | 37     | 36800           | 381               |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                           |          |                 |           |         |      |         |       |           |        |        |        |                 |                   |
| Wet Chemistry   |                           |          |                 |           |         |      |         |       |           |        |        |        |                 |                   |
| Field ID  | TOTAL DISSOLVED<br>SOLIDS | CHLORIDE | SULFATE         | NO3/NO2-N | CYANIDE |      |         |       |           |        |        |        |                 |                   |
| 07-135-GW-1   | 130                       | < 5.0    | 49              | 0.26      | NR      |      |         |       |           |        |        |        |                 |                   |
| 07-135-GW-2   | 137                       | < 5.0    | 51              | 0.27      | NR      |      |         |       |           |        |        |        |                 |                   |
| 07-135-SW-1   | 2720                      | < 5.0    | 1710            | 0.1       | NR      |      |         |       |           |        |        |        |                 |                   |
| 07-135-SW-2   | 2280                      | < 5.0    | 1410            | 0.08      | NR      |      |         |       |           |        |        |        |                 |                   |
| 07-135-SW-3   | 1040                      | < 5.0    | 642             | < 0.05    | NR      |      |         |       |           |        |        |        |                 |                   |
| 07-135-SW-4   | 732                       | < 5.0    | 466             | 0.1       | NR      |      |         |       |           |        |        |        |                 |                   |

**LEGEND**

SE2 - 150 feet below base of waste rock dump 2.  
 SE3 - At road crossing below residence (40' UP).  
 SE4 - Squaw Creek above Savage Mill and Carpenter Creek.  
 WR1 - Composite of subsamples WR1A, 1B, and 1C.  
 WR2 - Composite of subsamples WR2A through 2E.  
 BACKGROUND - 280' West of waste rock dump 1, from the Silver Dyke Adit (07-135-SS-1).

GW1 - Glen Hawthorne residence.  
 GW2 - Duplicate of sample 07-135-GW1.  
 SW1 - Adit discharge.  
 SW2 - Same as sample SE2.  
 SW3 - Same as sample SE3.  
 SW4 - Same as sample SE4.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Silver Dyke Tailings  
Legal Description: T 14N R 8E  
Mining District: Neihart  
Latitude: N 46° 58' 32"  
Longitude: W 110° 41' 43"  
Land Status: Public  
Quad: Neihart  
Inspectors: Tuesday, Belanger, Flammang,  
Clark, Lasher/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Cascade  
Section(s): SE 1/4, NW 1/4, Sec. 15  
Mine Type: Tailings from Hardrock mining  
and milling/Ag, Pb, Zn  
Primary Drainage: Belt Creek  
USGS Code: 10030105  
Secondary Drainage: Carpenter Creek  
Date Investigated: May 26, 1993  
P.A. # 07-137

- The volume of mill tailings remaining at this site was estimated at 56,350 cubic yards; an unknown volume of tailings, formerly at the site, had been deposited in the Carpenter Creek floodplain following a catastrophic failure of the tailings dam. The following elements were elevated at least three times ground (on-site tailings):

|                               |                              |
|-------------------------------|------------------------------|
| Arsenic: 48.1 to 64.5 mg/kg   | Barium: 836J to 1,040J mg/kg |
| Cadmium: 6.7JX to 8.1JX mg/kg | Copper: 1,140 to 5,510 mg/kg |
| Manganese: 2,120J mg/kg       | Lead: 2,920 to 14,200 mg/kg  |
- The tailings were uncontained, the dam was washed away during the failure. Tailings were actively eroding into a small tributary that bisected the tailings and discharged to Carpenter Creek. The tailings were unvegetated. Tailings materials were observed in the Carpenter Creek floodplain downstream from the site.
- No waste rock was associated with this site, though one of the tailings piles consists of small rock fragments of uniform size (1/2").
- An observed release to surface water for arsenic, barium, cadmium, copper, manganese, and lead was documented with sediment samples, and for copper, manganese, and lead in water samples. No exceedances of drinking water standards were documented. Aquatic life criteria exceedances for copper, lead, and zinc (acute) and mercury, copper, lead, and zinc (chronic) were documented at this site.
- No discharging adits, springs or seeps were found at the site.
- No hazardous structures or openings existed at the site. Potentially hazardous highwalls existed within the tailings due to the dam failure and subsequent undercut banks.



**Silver Dyke Tailings PA# 07-137**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 05/26/93**

**SOLID MATRIX ANALYSES**

| Metals in soils   |                | Results per dry weight basis   |                         |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
|---|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|------------|------------|------------|------------|-----------------|
| FIELD ID  | As (mg/Kg)     | Ba (mg/Kg)                     | Cd (mg/Kg)              | Co (mg/Kg)                       | Cr (mg/Kg)       | Cu (mg/Kg)       | Fe (mg/Kg)       | Hg (mg/Kg)                       | Mn (mg/Kg)                       | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 07-137-SE-1   | 17.7           | 67.3 J                         | 4.4 JX                  | 18.2 J                           | 28.3             | 63.5             | 26400            | 0.023                            | 855 J                            | 26.4 J     | 586 J      | 3.1 UJ     | 712 J      | NR              |
| 07-137-SE-2   | 55.9           | 469 J                          | 13.0 JX                 | 10.5 J                           | 14.3             | 6440             | 37300            | 0.034                            | 2950 J                           | 26 J       | 7440 J     | 3.34 UJ    | 1430 J     | NR              |
| 07-137-SE-3   | 14.1           | 79.1 J                         | 1.5 JX                  | 16.5 J                           | 31.5             | 55.8             | 21300            | 0.024                            | 317 J                            | 23.3 J     | 145 J      | 4.43 UJ    | 237 J      | NR              |
| 07-137-SE-4   | 70.9           | 724 J                          | 14.7 JX                 | 12.8 J                           | 45.2             | 3680             | 45500            | 0.074                            | 2670 J                           | 48.6 J     | 7730 J     | 4.36 UJ    | 1670 J     | NR              |
| 07-137-TP-1   | 48.1           | 836 J                          | 8.1 JX                  | 4.15 J                           | 11.9             | 4200             | 36600            | 0.057                            | 1080 J                           | 12.1 J     | 8620 J     | 2.96 UJ    | 816 J      | NR              |
| 07-137-TP-2   | 64.5           | 1040 J                         | 6.7 JX                  | 7.49 J                           | 20.7             | 5510             | 45000            | 0.067                            | 2120 J                           | 17.1 J     | 14200 J    | 3.51 UJ    | 798 J      | NR              |
| 07-137-TP-6   | 54.2           | 254 J                          | 6.7 JX                  | 8.55 J                           | 12.5             | 1140             | 31300            | 0.052                            | 1560 J                           | 16 J       | 2920 J     | 3.01 UJ    | 838 J      | NR              |
| BACKGROUND  | 10.5           | 131                            | 1.4                     | 6.83                             | 22.2             | 26.1             | 20600            | 0.048 U                          | 607                              | 15.6       | 667        | 3.39 UJ    | 548        | NR              |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                |                                |                         |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
| Acid/Base Accounting  |                |                                |                         |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
| FIELD ID  | TOTAL SULFUR % | TOTAL SULFUR ACID BASE 1/1000t | NEUTRAL POTENT. 1/1000t | SULFUR ACID BASE POTENT. 1/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE 1/1000t | SULFUR ACID BASE POTENT. 1/1000t |            |            |            |            |                 |
| 07-137-TP1  | 0.46           | 14.4                           | 6.20                    | -8.17                            | 0.16             | 0.08             | 0.22             | 2.50                             | 3.71                             |            |            |            |            |                 |
| 07-137-TP2  | 0.26           | 8.12                           | 8.34                    | 0.27                             | 0.14             | 0.04             | 0.08             | 1.25                             | 7.14                             |            |            |            |            |                 |
| 07-137-TP6  | 1.09           | 34.1                           | 8.64                    | -25.4                            | <0.01            | 0.59             | 0.50             | 18.4                             | -9.79                            |            |            |            |            |                 |

**WATER MATRIX ANALYSES**

| Metals in Water<br>Results in ug/L  |                              |          |         |           |         |  |      |        |        |        |        |        |        | HARDNESS<br>CALC.<br>Zn (mg CaCO3/L) |  |
|---|------------------------------|----------|---------|-----------|---------|--|------|--------|--------|--------|--------|--------|--------|--------------------------------------|--|
| FIELD<br>ID   | As                           | Ba       | Cd      | Co        | Cr      | Cu   | Fe   | Hg     | Mn     | Ni     | Pb     | Sb     | =====  |                                      |  |
| 07-137-SW-1   | 1.49 U                       | 9.4      | 2.55 U  | 5.99 U    | 9.03 J  | 1.35 U   | 20.1 | 0.15 J | 2.6 U  | 8.78 U | 1 U    | 18.3 U | 20 J   | 26.8                                 |  |
| 07-137-SW-2   | 1.49 U                       | 24.2     | 2.55 U  | 5.99 U    | 12.5 J  | 24.2   | 85.4 | 0.17 J | 15.8 J | 8.78 U | 32.2 J | 18.3 U | 80.5 J | 36.5                                 |  |
| 07-137-SW-3   | 1.49 U                       | 10.2     | 2.55 U  | 5.99 U    | 12.3 J  | 1.35 U   | 45.2 | 0.29 J | 2.6 U  | 8.78 U | 1.2 J  | 18.3 U | 6 U    | 23.1                                 |  |
| 07-137-SW-4   | 1.49 U                       | 11.4     | 2.55 U  | 5.99 U    | 6.43 J  | 3.8  | 62.8 | 0.15 J | 4.37 J | 8.78 U | 8.36 J | 18.3 U | 9.9 J  | 23.7                                 |  |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                              |          |         |           |         |  |      |        |        |        |        |        |        |                                      |  |
| Wet Chemistry<br>Results in mg/l  |                              |          |         |           |         | LEGEND   |      |        |        |        |        |        |        |                                      |  |
| FIELD<br>ID.  | TOTAL<br>DISSOLVED<br>SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE | SE1 - On unnamed tributary above site.<br>SE2 - On unnamed tributary at PPE above road.<br>SE3 - On Carpenter Creek above tailings site.<br>SE4 - On Carpenter Creek, 350' above confluence with Squaw Creek.<br>TP1 - Composite of holes 2A and 3B (estimated to be middle of existing pile).<br>TP2 - Composite of holes 2C and 3C (estimated to be lower portion of pile).<br>TP6 - Composite of holes on upper most pile closest to mill.<br>BACKGROUND - From Silver Dyke Adit (07-135-SS-1). |      |        |        |        |        |        |        |                                      |  |
| 07-137-SW1  | 62                           | < 5.0    | 8       | < 0.05    | NR      | SW1 - Same as sample SE1.  |      |        |        |        |        |        |        |                                      |  |
| 07-137-SW2  | 68                           | < 5.0    | 15      | < 0.05    | NR      | SW2 - Same as sample SE2.  |      |        |        |        |        |        |        |                                      |  |
| 07-137-SW3  | 47                           | < 5.0    | < 5.0   | < 0.05    | NR      | SW3 - Same as sample SE3.  |      |        |        |        |        |        |        |                                      |  |
| 07-137-SW4  | 54                           | < 5.0    | < 5.0   | 0.08      | NR      | SW4 - Same as sample SE4.  |      |        |        |        |        |        |        |                                      |  |

**LEGEND**

SE1 - On unnamed tributary above site.  
 SE2 - On unnamed tributary at PPE above road.  
 SE3 - On Carpenter Creek above tailings site.  
 SE4 - On Carpenter Creek, 350' above confluence with Squaw Creek.  
 TP1 - Composite of holes 2A and 3B (estimated to be middle of existing pile).  
 TP2 - Composite of holes 2C and 3C (estimated to be lower portion of pile).  
 TP6 - Composite of holes on upper most pile closest to mill.  
 BACKGROUND - From Silver Dyke Adit (07-135-SS-1).

SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.  
 SW3 - Same as sample SE3.  
 SW4 - Same as sample SE4.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Silver Dyke Mill  
Legal Description: T 14N R 8E  
Mining District: Neihart  
Latitude: N 46° 58' 42"  
Longitude: W 110° 41' 55"  
Land Status: Private  
Quad: Neihart  
Inspectors: Tuesday, Belanger, Flammanq,  
Lasher, Clark / Pierson  
Organization: Pioneer Technical Services,  
Inc./ Thomas, Dean and Hoskins, Inc.

County: Cascade  
Section(s): NE 1/4, NW 1/4, Sec. 15  
Mine Type: Hardrock / Ag, Pb, Zn  
Primary Drainage: Belt Creek  
USGS Code: 10030105  
Secondary Drainage: Squaw Creek  
Date Investigated: May 25, 1993  
P.A. # 07-138

- There were no mill tailings at this site. Tailings from this mill were transported to the east and were inventoried under the Silver Dyke Tailings, PA# 07-137
- The volume of waste rock associated with this site was estimated to be 82,600 cubic yards. The following elements were elevated at least three times background:

|                                 |                                   |
|---------------------------------|-----------------------------------|
| Arsenic: 69.8 to 182 mg/kg      | Barium: 450J mg/kg                |
| Cadmium: 12.7JX to 40.8JX mg/kg | Copper: 2,120 to 3,730 mg/kg      |
| Mercury: 0.291 to 0.366 mg/kg   | Manganese: 3,610J to 5,050J mg/kg |
| Lead: 4,830 to 4,380 mg/kg      | Zinc: 1,510 to 4,380 mg/kg        |
- The waste rock dumps were unvegetated and contained abundant sulfides.
- No discharging adits, springs or seeps were observed.
- Two large ore bins were collapsing and the mill building (with machinery) had mostly collapsed; all three were hazardous structures. Asbestos may have be present associated with old bearings and rollers or with insulation.

**Silver Dyke Mill PA# 07-138**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 05/25/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 07-138-TP-1 | 69.8          | 104 J         | 12.7 JX       | 13.4 J        | 12.1          | 2120          | 41700         | 0.024         | 5050 J        | 40.9 J        | 4830 J        | 3.03 UJ       | 1510 J        | NR                 |
| 07-138-WR-1 | 182           | 289 J         | 17.3 JX       | 7.88 J        | 13            | 2140          | 58900         | 0.366         | 996 J         | 13.4 J        | 8430 J        | 3.21 UJ       | 2300 J        | NR                 |
| 07-138-WR-2 | 111           | 450 J         | 40.8 JX       | 11.6 J        | 7.57          | 3730          | 39200         | 0.291         | 3610 J        | 28.2 J        | 8220 J        | 3.17 UJ       | 4380 J        | NR                 |
| BACKGROUND  | 10.5          | 131           | 1.4           | 6.83          | 22.2          | 26.1          | 20600         | 0.048 U       | 607           | 15.6          | 667           | 3.39 UJ       | 548           | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID   | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|------------|----------------------|---|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 07-138-TP1 | 1.26                 | 39.4                                    | 17.9                          | -21.5                                     | <0.01                  | 0.47                   | 0.80                   | 14.7                                      | 3.20                                      |
| 07-138-WR1 | 3.08                 | 96.2                                    | -18.8                         | -115                                      | 1.61                   | 0.41                   | 1.06                   | 12.8                                      | -31.7                                     |
| 07-138-WR2 | 2.17                 | 67.8                                    | 19.1                          | -48.7                                     | 0.60                   | 0.67                   | 0.90                   | 20.9                                      | -1.84                                     |

**LEGEND**

TP1 - Composite of subsamples TP1A, 1B, 1C, 2A, 2B, and 2C.  
WR1 - Composite of subsamples WR1A, 1B, and 1C.  
WR2 - Composite of subsamples WR2A, 2B, 2C, 3A, 3B, and 3C.  
BACKGROUND - From the Silver Dyke Adit (07-138-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |  |
|--|--|
| Mine/Site Name: <u>Sherman No. 2 (Northwest)</u> | County: <u>Cascade</u>                     |
| Legal Description: <u>T 14N R 8E</u>             | Section(s): <u>NW 1/4, SW 1/4, Sec. 15</u> |
| Mining District: <u>Neihart</u>                  | Mine Type: <u>Hardrock/Ag, Pb, Zn, Cu</u>  |
| Latitude: <u>N 46° 58' 27"</u>                   | Primary Drainage: <u>Belt Creek</u>        |
| Longitude: <u>W 110° 41' 52"</u>                 | USGS Code: <u>10030105</u>                 |
| Land Status: <u>Private/Public</u>               | Secondary Drainage: <u>Carpenter Creek</u> |
| Quad: <u>Neihart</u>                             | Date Investigated: <u>May 26, 1993</u>     |
| Inspectors: <u>Tuesday/Pierson</u>               | P.A. # <u>07-140</u>                       |
| Organization: <u>Pioneer Technical Services,</u> |  |
| <u>Inc./ Thomas, Dean and Hoskins, Inc.</u>      |  |

- There were no mill tailings that were from this site; tailings were present in the Carpenter Creek floodplain below the adit at this site, but they originated upstream from the dam failure at the Silver Dyke Tailings site.
- There was no waste rock observed at this site. It may have washed away or been buried during the dam failure event. No source samples were collected.
- No adit discharges, seeps or springs were observed.
- This site was associated with the Sherman #2 (southwest) PA# 07-142. The adit was approximately 60' from Carpenter Creek.
- No observed releases or exceedances of drinking water standards or aquatic life criteria were documented during this investigation; no surface water samples were collected.
- One mine opening was on site, a partially caved adit that was accessible.





**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Sherman No. 2 (Southwest)  
Legal Description: T 14N R 8E  
Mining District: Neihart  
Latitude: N 46° 58' 23"  
Longitude: W 110° 41' 56"  
Land Status: Private/Public  
Quad: Neihart  
Inspectors: Tuesday, Belanger, Clark,  
Lasher/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Cascade  
Section(s): NW 1/4, SW 1/4, Sec. 15  
Mine Type: Hardrock/Ag, Pb, Zn, Cu  
Primary Drainage: Belt Creek  
USGS Code: 10030105  
Secondary Drainage: BurgCreek/Carpenter  
Creek  
Date Investigated: May 26, 1993  
P.A. # 07-142

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be 200 cubic yards. The following elements were elevated at least three times background (using XRF data):  
Iron: 66,590 mg/kg                      Manganese: 2,946 to 5,792 mg/kg  
Lead: 8,605 mg/kg                      Zinc: 3,862 to 4,760 mg/kg
- There was a very small discharge (<1gpm) from the adit which may have been seepage from adjacent Burg Creek. The discharge had a pH of 7.1 and SC of 110 us/cm. No other seeps or springs were observed.
- Tailings were in the Carpenter Creek floodplain below this site, but were from upstream dam failure at Silver Dyke Tailings site.
- No observed releases or exceedences of drinking water standards or aquatic life criteria were documented during this investigation; no surface water samples were collected.
- One mine opening was onsite, a partially caved adit that was accessible. A hazardous loadout structure was also at the site.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |  |
|--|--|
| Mine/Site Name: <u>Big Seven</u>                 | County: <u>Cascade</u>                     |
| Legal Description: <u>T 14N R 8E</u>             | Section(s): <u>SE 1/4, NE 1/4, Sec. 28</u> |
| Mining District: <u>Neihart</u>                  | Mine Type: <u>Hardrock/Au, Ag, Pb, Zn</u>  |
| Latitude: <u>N 46° 56' 55"</u>                   | Primary Drainage: <u>Belt Creek</u>        |
| Longitude: <u>W 110° 42' 15"</u>                 | USGS Code: <u>10030105</u>                 |
| Land Status: <u>Private/Public</u>               | Secondary Drainage: <u>Snow Creek</u>      |
| Quad: <u>Neihart</u>                             | Date Investigated: <u>May 27, 1993</u>     |
| Inspectors: <u>Tuesday, Flammang, Lasher,</u>    | P.A. # <u>07-156</u>                       |
| <u>Clark, Belanger / Pierson</u>                 |  |
| Organization: <u>Pioneer Technical Services,</u> |  |
| <u>Inc./ Thomas, Dean and Hoskins, Inc.</u>      |  |

- The mill tailings associated with this site were impounded in one pond (TP-3) and 2 piles (TP-1 and -2). They were in the floodplain of a small tributary of Snow Creek and extended at least 1,000 feet downstream from the site. The volume of these tailings was estimated at 2,580 cubic yards and were 40% revegetated (naturally). The following elements were elevated at least three times background:

|                           |                                 |
|---------------------------|---------------------------------|
| Arsenic: 121 to 212 mg/kg | Cadmium: 9.5 to 13.5JX mg/kg    |
| Mercury: 0.071 mg/kg      | Manganese: 2,710 to 6,860 mg/kg |
| Antimony: 15.2 mg/kg      | Zinc: 2,430 to 2,740 mg/kg      |
- The volume of waste rock associated with this site was estimated to be 25,800 cubic yards. The following elements were elevated at least three times background:

|                           |                            |
|---------------------------|----------------------------|
| Arsenic: 246 to 381 mg/kg | Cadmium: 2.0 to 10.2 mg/kg |
| Manganese: 1,280 mg/kg    | Lead: 2,880 mg/kg          |
| Zinc: 2,200 mg/kg         |                            |
- An observed release to surface water (tributary of Snow Creek) was documented in sediments for mercury and manganese, and in water samples for zinc and manganese. Exceedances of drinking water standards were recorded for cadmium; and aquatic life criteria for mercury, cadmium, lead, and zinc (chronic), cadmium and zinc (acute) were documented in surface water at the Big Seven site.
- One discharging adit had a significant flow (0.06 cfs) with significant iron staining 1,000 feet downstream. The adit water (SW-3) had a pH of 6.63, an specific conductance of 500 us/cm, and exceeded drinking water standards for cadmium and nickel; aquatic life criteria for mercury, cadmium, lead, and zinc (chronic), and cadmium and zinc (acute) were also exceeded in the adit discharge.
- Several buildings were at the site, but most appeared in fair condition. There were two open adits at the site.



**Big Seven PA# 07-156**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 05/27/93**

| Metals in soils      |                |                                | Results per dry weight basis (mg/kg) |                                  |                  |                  |                  |                                  |                                  | SOLID MATRIX ANALYSES |        |         |        |         |  |
|----------------------|----------------|--------------------------------|--------------------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|-----------------------|--------|---------|--------|---------|--|
| FIELD ID             | As             | Ba                             | Cd                                   | Co                               | Cr               | Cu               | Fe               | Hg                               | Mn                               | Ni                    | Pb     | Sb      | Zn     | CYANIDE |  |
| 07-156-SE-1          | 242            | 161                            | 11.1                                 | 19.4                             | 13.4             | 73.2             | 37800            | 0.017 U                          | 2870                             | 36.8                  | 518    | 14.1 J  | 2900   | NR      |  |
| 07-156-SE-4          | 10.7           | 175                            | 0.4 U                                | 20.6                             | 138              | 48               | 38400            | 0.016 U                          | 863                              | 67.4                  | 111    | 5.12 J  | 312    | NR      |  |
| 07-156-SE-5          | 124            | 715 J                          | 22.3 J                               | 42.1 J                           | 31.7 J           | 98.9             | 39000            | 0.129                            | 18300                            | 147                   | 887    | 5.94 UJ | 4150   | NR      |  |
| 07-156-TP-2          | 212            | 365 J                          | 13.5 JX                              | 7.32 J                           | 13.3             | 55.7             | 27100            | 0.071                            | 4140 J                           | 36 J                  | 2510 J | 3.03 UJ | 2740 J | NR      |  |
| 07-156-TP-3A         | 121            | 174                            | 9.5                                  | 3.27                             | 18.1             | 47.2             | 17900            | 0.016 U                          | 2710                             | 20.4                  | 434    | 9.51 J  | 2430   | NR      |  |
| 07-156-TP-3B         | 126            | 139                            | 9.7                                  | 7.48                             | 30.3             | 52.1             | 29700            | 0.017 U                          | 6860                             | 47.6                  | 576    | 15.2 J  | 2530   | 1.279 U |  |
| 07-156-WR-1          | 381            | 97.2                           | 2.0                                  | 14.8                             | 22.8             | 56.8             | 55100            | 0.014 U                          | 1280                             | 17.2                  | 506    | 5.29 J  | 785    | NR      |  |
| 07-156-WR-2          | 288            | 118                            | 1.0                                  | 1.4                              | 11               | 76               | 33000            | 0.014 U                          | 146                              | 3.67                  | 2880   | 9.94 J  | 631    | NR      |  |
| 07-156-WR-3          | 246            | 164                            | 0.5 U                                | 1.71                             | 17.6             | 39.2             | 32700            | 0.016 U                          | 71.2                             | 5.1                   | 956    | 7.02 J  | 368    | NR      |  |
| 07-156-WR-4          | 265            | 62.3                           | 10.2                                 | 1.22 U                           | 8.97             | 53.8             | 30900            | 0.014 U                          | 47.8                             | 4.96                  | 1220   | 11.2 J  | 2200   | NR      |  |
| BACKGROUND           | 15.1           | 166                            | 0.6 U                                | 6.73                             | 25.1             | 28.3             | 26600            | 0.02 U                           | 422                              | 16.5                  | 420    | 4.33 UJ | 336    | NR      |  |
| Acid/Base Accounting |                |                                |                                      |                                  |                  |                  |                  |                                  |                                  |                       |        |         |        |         |  |
| FIELD ID             | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t             | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |                       |        |         |        |         |  |
| 07-156-SL1           | 0.03           | 0.94                           | -0.33                                | -1.27                            | 0.02             | <0.01            | 0.01             | 0.00                             | -0.33                            |                       |        |         |        |         |  |
| 07-156-TP3A          | 0.48           | 15.0                           | 12.9                                 | -2.11                            | 0.05             | 0.25             | 0.18             | 7.81                             | 5.08                             |                       |        |         |        |         |  |
| 07-156-TP3B          | 0.74           | 23.1                           | 21.4                                 | -1.14                            | 0.02             | 0.44             | 0.28             | 13.7                             | 8.19                             |                       |        |         |        |         |  |
| 07-156-TP-2          | 1.19           | 35.9                           | 37.3                                 | 1.38                             | 0.18             | 0.46             | 0.51             | 14.4                             | 22.9                             |                       |        |         |        |         |  |
| 07-156-WR1           | 2.05           | 64                             | -3.97                                | -68                              | 1.98             | 0.01             | 0.06             | 0.31                             | -4.28                            |                       |        |         |        |         |  |
| 07-156-WR2           | 1.56           | 48.7                           | -2.06                                | -50.8                            | 1.51             | <0.01            | 0.05             | 0.00                             | -2.06                            |                       |        |         |        |         |  |
| 07-156-WRD3          | 0.83           | 25.9                           | -3.37                                | -29.3                            | 0.8              | <0.01            | 0.03             | 0.00                             | -3.37                            |                       |        |         |        |         |  |
| 07-156-WR-4          | 0.46           | 14.4                           | 0.33                                 | -14.0                            | 0.45             | <0.01            | 0.01             | 0.00                             | 0.33                             |                       |        |         |        |         |  |
| 07-156-TP3BDUP       | 0.76           | 23.7                           | 21.4                                 | -2.31                            | 0.02             | 0.45             | 0.29             | 14.1                             | 7.37                             |                       |        |         |        |         |  |

| Metals in Water |        | Results in ug/L |         |           |         |   |        |        |         |        |        |        |                 |       | WATER MATRIX ANALYSES   |  | HARDNESS |  |
|-----------------|--------|-----------------|---------|-----------|---------|---|--------|--------|---------|--------|--------|--------|-----------------|-------|---|--|----------|--|
| FIELD ID        | As     | Ba              | Cd      | Co        | Cr      | Cu  | Fe     | Hg     | Mn      | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | CALC. |   |  |          |  |
| 07-156-SW-1     | 1.5 J  | 8.73            | 5       | 6.47      | 5.7 J   | 9.17  | 643    | 0.3 J  | 2790 J  | 38.7   | 6.17 J | 18.3 U | 1910 J          | 82.1  |   |  |          |  |
| 07-156-SW-2     | 2.38 J | 18.3            | 10.2    | 5.99 U    | 5 U     | 12.2  | 20.1   | 0.18 J | 590 J   | 13.6   | 2.25 J | 18.3 U | 1230 J          | 25.3  |   |  |          |  |
| 07-156-SW-3     | 2.84 J | 11.1            | 13.9    | 45        | 5 U     | 34.8  | 11400  | 0.13 J | 14500 J | 169    | 8.16 J | 18.3 U | 6810 J          | 161   |   |  |          |  |
| 07-156-SW-4     | 1.55 J | 24.7            | 8.17    | 5.99 U    | 5 U     | 10.5  | 238    | 0.21 J | 2080 J  | 83.8   | 3.33 J | 18.3 U | 4990 J          | 243   |   |  |          |  |
| 07-156-SW-5     | 1.49 U | 2.24 U          | 2.55 U  | 5.99 U    | 5.17 J  | 3.67  | 13.5 U | 0.1 J  | 4.4 J   | 8.78 U | 1 U    | 18.3 U | 6 U             | 8.8   |   |  |          |  |
| Wet Chemistry   |        |                 |         |           |         |   |        |        |         |        |        |        |                 |       | U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |  |          |  |
| FIELD ID        | TDS    | CHLORIDE        | SULFATE | NO3/NO2-N | CYANIDE | LEGEND  |        |        |         |        |        |        |                 |       |   |  |          |  |
| 07-156-SW1      | 135    | < 5.0           | 84      | 0.11      | NR      | TP2 - Sample of the TP2 subsample.                      |        |        |         |        |        |        |                 |       |   |  |          |  |
| 07-156-SW2      | 69     | < 5.0           | 37      | < 0.05    | NR      | TP3A - Sample of the TP3A subsample.                    |        |        |         |        |        |        |                 |       |   |  |          |  |
| 07-156-SW3      | 328    | < 5.0           | 213     | < 0.05    | NR      | TP3B - Sample of the TP3B subsample.                    |        |        |         |        |        |        |                 |       |   |  |          |  |
| 07-156-SW4      | 377    | < 5.0           | 240     | 0.12      | NR      | WR1 - Composite of subsamples WR1A, 1B, and 1C.         |        |        |         |        |        |        |                 |       |   |  |          |  |
| 07-156-SW5      | 18     | < 5.0           | < 5.0   | < 0.05    | NR      | WR2 - Composite of WR2A, 2B, and 2C.                    |        |        |         |        |        |        |                 |       |   |  |          |  |
|                 |        |                 |         |           |         | WR3 - Composite of subsamples WR3A, 3B, and 3C.         |        |        |         |        |        |        |                 |       |   |  |          |  |
|                 |        |                 |         |           |         | WR4 - Composite of subsamples WR4A, 4B, and 4C.         |        |        |         |        |        |        |                 |       |   |  |          |  |
|                 |        |                 |         |           |         | SE1 - At junction of two streams below mine.            |        |        |         |        |        |        |                 |       |   |  |          |  |
|                 |        |                 |         |           |         | SE4 - Below final impoundment from wood culvert.        |        |        |         |        |        |        |                 |       |   |  |          |  |
|                 |        |                 |         |           |         | SE5 - Below site but before confluence with Snow Creek. |        |        |         |        |        |        |                 |       |   |  |          |  |
|                 |        |                 |         |           |         | SW1 - Above tailings.                                   |        |        |         |        |        |        |                 |       |   |  |          |  |
|                 |        |                 |         |           |         | SW2 - Below waste rock dump 3.                          |        |        |         |        |        |        |                 |       |   |  |          |  |
|                 |        |                 |         |           |         | SW3 - Adit #1 discharge.                                |        |        |         |        |        |        |                 |       |   |  |          |  |
|                 |        |                 |         |           |         | SW4 - Same as sample SE4.                               |        |        |         |        |        |        |                 |       |   |  |          |  |

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Baker  
Legal Description: T 14N R 8E  
Mining District: Neihart  
Latitude: N 46° 58' 39"  
Longitude: W 110° 42' 40"  
Land Status: Private  
Quad: Neihart  
Inspectors: Bullock, Clark/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Cascade  
Section(s): SW 1/4, NE 1/4, Sec. 16  
Mine Type: Hardrock/Ag, Au, Zn, Pb, Cu  
Primary Drainage: Belt Creek  
USGS Code: 10030105  
Secondary Drainage: Mackay Creek  
Date Investigated: July 29, 1993  
P.A. # 07-180

- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 455 cubic yards. The following elements were elevated at least three times background:  
Barium: 394J mg/kg      Antimony: 14J mg/kg  
Copper: 163J mg/kg      Mercury: 0.95J mg/kg
- Two minor unnamed tributaries to McKay Creek were flowing at the time of the investigation. One of the tributaries flowed through WR-1 (pH = 7.24), the other tributary flowed near WR-2 (pH = 6.14). Both tributaries were sampled for field parameters only.
- Surface water samples of McKay Creek were collected during the Vilipa site investigation. The Vilipa site was located in the drainage below the Baker site. No MCLs were exceeded in upstream or downstream McKay Creek samples; however, acute and chronic aquatic life criteria were exceeded for zinc, and chronic aquatic life criteria were exceeded for mercury, copper, and lead in both upstream and downstream samples. The acute aquatic life criteria for copper was exceeded in the downstream sample. A downstream sediment sample indicated elevated concentrations of barium, copper, mercury, and manganese.
- Two potentially hazardous partially open adits were identified at the site, and two of the dumps were eroded and unstable.

**Baker PA# 07-180**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/29/93**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 07-180-WR-1 | 11            | 394 J         | 1.3           | 1.5 U         | 1.7           | 163 J         | 19000         | 0.95 J        | 9.9           | 2 U           | 1060 J        | 14 J          | 68 J          | NR                 |
| BACKGROUND  | 10.5          | 131           | 1.4           | 6.83          | 22.2          | 26.1          | 20600         | 0.048 U       | 607           | 15.6          | 667           | 3.39 UJ       | 548           | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR ACID BASE<br>t/1000t | NEUTRAL POTENT.<br>t/1000t | SULFUR ACID BASE POTENT.<br>t/1000t | SULFATE SULFUR<br>% | PYRITIC SULFUR<br>% | ORGANIC SULFUR<br>% | PYRITIC SULFUR ACID BASE<br>t/1000t | SULFUR ACID BASE POTENT.<br>t/1000t |
|-------------|-------------------|-----------------------------------|----------------------------|-------------------------------------|---------------------|---------------------|---------------------|-------------------------------------|-------------------------------------|
| 07-180-WR-1 | 0.19              | 5.94                              | -2.02                      | -7.96                               | 0.16                | 0.01                | 0.02                | 0.31                                | -2.33                               |

**LEGEND**

WR1 - Composite of subsamples WR1 and 2  
BACKGROUND - From the Silver Dyke Adit (07-135-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Champion</u>                       | County: <u>Deerlodge</u>                   |
| Legal Description: T <u>6N</u> R <u>8W</u>            | Section(s): <u>NE 1/4, NW 1/4, Sec. 33</u> |
| Mining District: <u>Orofino</u>                       | Mine Type: <u>Hardrock/Ag</u>              |
| Latitude: <u>N 46° 13' 55"</u>                        | Primary Drainage: <u>Orofino Creek</u>     |
| Longitude: <u>W 112° 36' 40"</u>                      | USGS Code: <u>12010201</u>                 |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Orofino Creek</u>   |
| Quad: <u>Lockhart Meadows</u>                         | Date Investigated: <u>July 16, 1993</u>    |
| Inspectors: <u>Bullock, Flammang, Clark</u>           | P.A. # <u>12-003</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- The volume of tailings associated with this site was estimated to be approximately 5,700 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 74 mg/kg                      Mercury: 0.869 mg/kg  
Chromium: 39.5 mg/kg                  Lead: 37 mg/kg
- The volume of waste rock associated with this site was estimated to be 6,500 cubic yards. There were no elements found to be elevated greater than three times background.
- There was one discharging adit identified at this site. This discharge was characterized by sample GW-1. The flow from the adit was measured at 0.027 cfs, the pH was 5.92, and specific conductance was 540 umhos/cm. The MCL/MCLG for cadmium was exceeded. In addition, the chronic aquatic life criteria for iron was exceeded. A strong hydrogen sulfide odor emanated from the adit.
- There was an unnamed tributary to Orofino Creek identified to be associated with this site. Samples were collected up and down stream from the site and were characterized by samples SW-2 and SW-1, respectively. No MCLs or aquatic life criteria exceedances were attributable to the site. Stream sediment samples were also collected from the unnamed tributary upstream and downstream from the site; observed releases were documented for arsenic and chromium that were directly attributed to this site.
- The ore bin/loadout on WR-2 was classified as a hazard structure.
- There was approximately 100 pounds of asbestos-containing material located at this site, that was scattered around the upper cement foundation east of adit #1.



**Champion PA# 12-003**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/16/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 12-003-SE-1 | 49         | 175        | 1.7        | 71.9       | 14.5       | 32.6       | 25500      | 0.305      | 3560       | 42         | 24         | 7 UJ       | 143        | NR              |
| 12-003-SE-2 | 7          | 67.2       | 0.6 U      | 7.2        | 4.5        | 8.3        | 11000      | 0.142      | 389        | 3 U        | 12         | 8 UJ       | 30         | NR              |
| 12-003-TP-1 | 74         | 34         | 0.7        | 5.5        | 39.5       | 16.3       | 15700      | 0.869      | 238        | 9          | 37         | 7 UJ       | 33         | NR              |
| 12-003-WR-1 | 54         | 30.4       | 1          | 9.5        | 22.6       | 39.5       | 26800      | 0.297      | 438        | 6          | 21         | 7 UJ       | 39         | NR              |
| BACKGROUND  | 24         | 289        | 1.6        | 17.4       | 7.8        | 17.2       | 17600      | 0.106      | 1760       | 5          | 11         | 7 UJ       | 64         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 12-003-WR-1 | 0.61           | 19.1                           | 13.6                    | -5.5                             | 0.48             | 0.01             | 0.12             | 0.31                             | 13.3                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba    | Cd      | Co     | Cr     | Cu     | Fe    | Hg      | Mn     | Ni     | Pb     | Sb     | HARDNESS CALC. Zn (mg CaCO3/L) |
|-------------|--------|-------|---------|--------|--------|--------|-------|---------|--------|--------|--------|--------|--------------------------------|
| 12-003-GW-1 | 4.68 J | 8.47  | 10.20 J | 75.60  | 6.83 U | 1.55 U | 62800 | 0.038 U | 11600  | 55.1   | 1.04 J | 30.7 U | 14                             |
| 12-003-SW-1 | 3.54   | 41.9  | 5.67 J  | 9.7 U  | 6.83 U | 1.6    | 65    | 0.038 U | 146    | 12.7 U | 1.55 U | 30.7 U | 7.57 U                         |
| 12-003-SW-2 | 2.81 J | 38.20 | 2.57 U  | 9.70 U | 6.83 U | 1.55 U | 11.8  | 0.038 U | 4.08 U | 12.7 U | 0.83 J | 30.7 U | 7.57 U                         |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID.   | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 12-003-GW-1 | 984                    | 5.3      | 539     | < 0.05    | NR      |
| 12-003-SW-1 | 163                    | < 5.0    | 35      | < 0.05    | NR      |
| 12-003-SW-2 | 151                    | < 5.0    | 18      | < 0.05    | NR      |

**LEGEND**

SE1 - 25' from tailings berm; downstream.  
SE2 - Upstream from old cabin and small collapsed adit.  
TP1 - Composite of TP1A-A through 1A-C, 1B-A through 1B-C, and 1C-A.  
WR1 - Composite of subsamples WR1A, 1B, 1C, 2A, 2B, and 2C.  
BACKGROUND - From the Champion Mine (12-003-SS-1).

GW1 - Discharge from adit #1.  
SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Cable Mine  
Legal Description: T 5N R 13W  
Mining District: Silver Lake  
Latitude: N 46° 12' 02"  
Longitude: W 113° 13' 00"  
Land Status: Private  
Quad: Silver Lake  
Inspectors: Babits/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Deerlodge  
Section(s): SW 1/4, Sec. 10  
Mine Type: Hardrock/Au, Ag, Cu, Tungsten  
Primary Drainage: Warm Springs Creek  
USGS Code: 17010201  
Secondary Drainage: Cable Creek  
Date Investigated: September 10, 1993  
P.A. # 12-002

- The site was active. No samples were collected.
- The tailings were piled for reprocessed.
- Most waste rock had already been reprocessed.
- The water from the discharging adit was piped to the reprocessing facility.
- Cable Creek was approximately 0.5 miles from the site. The active mine operation was approximately 1,000 feet from the creek.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Gold Coin  
Legal Description: T 5N R 13W  
Mining District: Silver Lake  
Latitude: N 46° 10' 31"  
Longitude: W 113° 14' 45"  
Land Status: Private  
Quad: Silver Lake  
Inspectors: Tuesday, Belanger, Lasher  
Organization: Pioneer Technical Services  
Inc.

County: Deerlodge  
Section(s): SE 1/4, NE 1/4, Sec. 20  
Mine Type: Private  
Primary Drainage: Warm Springs Creek  
USGS Code: 17010201  
Secondary Drainage: Daily Gulch  
Date Investigated: June 25, 1993  
P.A. # 12-004

- The volume of tailings associated with this site was estimated to be approximately 9,367 cubic yards. The tailings were partially revegetated naturally. TP-1 was situated directly in a small wetland located near the highway, and TP-3 was situated directly in Daily Lake. Cyanide measurements varied from non-detect to 21.09 mg/kg in the tailings. The following elements were elevated at least three times background:  
Arsenic: 207 to 270 mg/kg                      Antimony: 16 mg/kg  
Iron: 79,700 to 90,100 mg/kg                      Zinc: 309 mg/kg  
Mercury: 0.943J to 1.75J mg/kg
- The volume of waste rock associated with this site was estimated to be approximately 27,200 cubic yards. The following elements were elevated at least three times background:  
Iron: 69,900 mg/kg                      Antimony: 15 mg/kg  
Mercury: 0.729J mg/kg
- There were no flowing adits, filled shafts, seeps, or springs observed at the site during the investigation. A surface water sample was collected from Daily Lake, no MCLs or acute or chronic aquatic life criteria were exceeded. The pH measurement in the lake sample was 8.39.
- One potentially hazardous open adit was observed at the site, all other adits were closed and the shaft was fenced. The mill building was in relatively poor condition and potentially hazardous.



**Gold Coin PA# 12-004**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 06/26/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 12-004-TP-1 | 270        | 218 J      | 0.5 U      | 3.3        | 3.7        | 23.8       | 79700      | 1.75 J     | 392 J      | 8 J        | 13         | 16         | 80         | 0.276 U         |
| 12-004-TP-3 | 207        | 151 J      | 0.4 U      | 7.9        | 10.6       | 27.9       | 90100      | 0.943 J    | 401 J      | 12 J       | 20         | 6          | 309        | 21.1            |
| 12-004-WR-1 | 187        | 48.1 J     | 0.4 U      | 4.9        | 3.6        | 33.3       | 69900      | 0.729 J    | 387 J      | 8 J        | 21         | 15         | 68         | NR              |
| BACKGROUND  | 64         | 144        | 0.5 U      | 7.1        | 12.1       | 42.9       | 12800      | 0.025 J    | 597        | 13         | 27         | 5 J        | 92         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID       | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|----------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 12-004-TP-1    | <0.01          | 0                              | 479                     | 479                              | <0.01            | <0.01            | 0.01             | 0                                | 479                              |
| 12-004-TP-1DUP | <0.01          | 0                              | 472                     | 472                              | <0.01            | <0.01            | 0.01             | 0                                | 472                              |
| 12-004-TP-3    | <0.01          | 0                              | 172                     | 172                              | <0.01            | <0.01            | 0.01             | 0                                | 172                              |
| 12-004-WR-1    | <0.01          | 0                              | 924                     | 924                              | <0.01            | 0.07             | 0.05             | 2.19                             | 922                              |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co    | Cr     | Cu  | Fe  | Hg      | Mn   | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|------|--------|-------|--------|-----|-----|---------|------|--------|------|--------|-----------------|----------------|
| 12-004-SW-1 | 41.7 | 60.5 | 2.57 U | 9.7 U | 6.83 U | 3.2 | 718 | 0.038 U | 39.2 | 12.7 U | 3.25 | 30.7 U | 7.57 U          | 181            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 12-004-SW-1 | 271                    | < 5.0    | 117     | 0.06      | NR      |

**LEGEND**

TP1 - Composite of subsamples TP1A and 1B.  
TP3 - Composite of subsamples 3A-1, 3A-2, 3A-3, and 3A-4.  
WR1 - Composite of subsamples WR1A, 1B, 1C, 2A, 2B, and 2C.  
BACKGROUND - From the Silver Lake Millsite (12-070-SS-1).  
TP1DUP - Duplicate of sample 12-004-TP-1.

SW1 - Daly Lake.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Silver Lake Millsite  
Legal Description: T 5N R 13W  
Mining District: Silver Lake  
Latitude: N 46° 09' 59"  
Longitude: W 113° 14' 22"  
Land Status: Private/Public  
Quad: Silver Lake  
Inspectors: Bullock, Flammang, Lasher  
Organization: Pioneer Technical Services, Inc.

County: Deerlodge  
Section(s): SW 1/4, SW 1/4, Sec. 21  
Mine Type: Mill/Wulferlite, Scheelite  
Primary Drainage: Flint Creek  
USGS Code: 17010202  
Secondary Drainage:  
Date Investigated: June 25, 1993  
P.A. # 12-070

- The volume of tailings associated with this site was estimated to be approximately 11,170 cubic yards. The following elements were elevated at least three times background:  
Mercury: 0.133J to 0.275J mg/kg
- No waste rock was observed at this site during the investigation.
- There were no adit discharges observed at the site during the investigation; however, a pond containing submerged tailings was located on-site. Surface water and sediment samples were collected from the pond. No MCLs or acute or chronic aquatic criteria were exceeded; however, the concentration of mercury in the pond sediment was significantly elevated (greater than three times) above background and was attributable to the site.
- A groundwater sample was collected from a residential well located 250 feet northwest of the site. No MCL/MCLGs were exceeded in this sample.
- Potentially hazardous structures associated with this site included the mill, two sheds, and a trailer.
- Several drums/containers containing petroleum products and unknown materials were located on site, one full 55-gallon barrel of unknown content was in poor condition and at risk of rupturing.

**Silver Lake Millsite PA# 12-070**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/25/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 12-070-SE-1 | 7             | 119 J         | 0.9           | 4.9           | 10.5          | 53.8          | 8850          | 0.206 J       | 157 J         | 11 J          | 41            | 6 U           | 106           | NR                 |
| 12-070-TP-1 | 6             | 68.4 J        | 1.4           | 1.7           | 3.4           | 37.2          | 3100          | 0.275 J       | 364 J         | 9 J           | 67            | 3 U           | 109           | NR                 |
| 12-070-TP-2 | 3 U           | 127 J         | 0.5 U         | 1.2 U         | 1.2           | 8.6           | 786           | 0.133 J       | 103 J         | 5 J           | 5             | 4 U           | 37            | NR                 |
| BACKGROUND  | 64            | 144           | 0.5 U         | 7.1           | 12.1          | 42.9          | 12800         | 0.025 J       | 597           | 13            | 27            | 5 J           | 92            | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 12-070-TP-1 | <0.01             | 0                                    | 855                           | 855                                       | <0.01                  | 0.18                   | <0.01                  | 5.62                                      | 849                                       |
| 12-070-TP-2 | <0.01             | 0                                    | 919                           | 919                                       | <0.01                  | 0.02                   | <0.01                  | 0.62                                      | 919                                       |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu   | Fe     | Hg      | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS<br>CALC. |
|-------------|--------|------|--------|-------|--------|------|--------|---------|--------|--------|--------|--------|-----------------|-------------------|
| 12-070-GW-1 | 0.98 U | 18   | 2.57 U | 9.7 U | 6.83 U | 4.77 | 11.8 U | 0.1     | 4.4    | 12.7 U | 0.38 U | 30.7 U | 7.57 U          | 88.2              |
| 12-070-GW-2 | 1.01   | 17.4 | 2.57 U | 9.7 U | 6.83 U | 5.8  | 11.8 U | 0.059   | 4.08 U | 12.7 U | 0.59   | 30.7 U | 7.57 U          | 86.9              |
| 12-070-SW-1 | 2.93   | 23.5 | 2.57 U | 9.7 U | 6.83 U | 2.43 | 79     | 0.038 U | 4.08 U | 12.7 U | 1.41   | 30.7 U | 7.57 U          | 87.8              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED<br>SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|---------------------------|----------|---------|-----------|---------|
| 12-070-GW-1 | 124                       | < 5.0    | 9       | 0.13      | < 0.01  |
| 12-070-GW-2 | 137                       | < 5.0    | 9       | 0.12      | < 0.01  |
| 12-070-SW-1 | 125                       | < 5.0    | 9       | < 0.05    | < 0.01  |

**LEGEND**

SE1 - North side of pond near overflow.  
TP1 - Composite of subsamples TP1A-A, 1A-B, 1A-C, 1B-A, 1B-B, and 1B-C.  
TP2 - Composite of subsamples TP2A and 2B.  
BACKGROUND - From Silver Lake Millsite (12-070-SS-1).

GW1 - Residential well 250' Northwest of site.  
GW2 - QA duplicate of sample 12-070-GW-1.  
SW1 - Same as sample SE1.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Tail Holt</u>                      | County: <u>Fergus</u>                        |
| Legal Description: <u>T 17N R 20E</u>                 | Section(s): <u>SE 1/4, NE 1/4, Sec. 30</u>   |
| Mining District: <u>Warm Springs</u>                  | Mine Type: <u>Hardrock/Au, Ag</u>            |
| Latitude: <u>N 47° 12' 27"</u>                        | Primary Drainage: <u>Fords Creek</u>         |
| Longitude: <u>W 109° 12' 35"</u>                      | USGS Code: <u>10040204</u>                   |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Collar Gulch</u>      |
| Quad: <u>Judith Peak</u>                              | Date Investigated: <u>September 11, 1993</u> |
| Inspectors: <u>Bullock, S. Babits</u>                 | P.A. # <u>14-010</u>                         |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no mill tailings positively identified at this site during the investigation. The material constituting WR-2 was well sorted crushed rock that may have been put through an on site milling process
- The volume of waste rock associated with this site was estimated to be approximately 3,800 cubic yards. The following elements were elevated at least three times background:

|                       |                  |
|-----------------------|------------------|
| Arsenic: 283 mg/kg    | Copper: 61 mg/kg |
| Mercury: 0.748J mg/kg |                  |
- One adit discharge was observed at the site during the investigation. The adit discharge seeped into WR-1 but did not resurface at the toe of the dump. No MCLs were exceeded in the discharge; however, the acute and chronic aquatic life criteria for copper and the chronic aquatic life criteria for lead and mercury were exceeded. No other surface water was observed on or near the site.
- Potentially hazardous mine openings associated with this site included the adit and the air raise south of the site.



**Tail Holt PA# 14-010**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 09/11/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 14-010-WR-1 | 283        | 112        | 0.8 U      | 9.2        | 1.43       | 61         | 31900      | 0.748 J    | 1080       | 4.17       | 69.4       | 5.77 UJ    | 152        | NR              |
| BACKGROUND  | 31.8       | 226        | 0.8 U      | 6.41       | 8.08       | 14.1       | 20700      | 0.039 J    | 3060       | 12         | 45.5       | 5.67 UJ    | 107        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 14-010-WR-1 | 0.47           | 14.7                           | 12.5                    | -2.2                             | 0.09             | 0.24             | 0.14             | 7.5                              | 4.98                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As      | Ba   | Cd     | Co    | Cr     | Cu   | Fe  | Hg   | Mn   | Ni     | Pb  | Sb       | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|---------|------|--------|-------|--------|------|-----|------|------|--------|-----|----------|-----------------|----------------|
| 14-010-GW-1 | 4.32 JX | 31.2 | 2.57 U | 9.7 U | 6.83 U | 36.4 | 857 | 0.14 | 82.6 | 12.7 U | 6.6 | 30.7 UJX | 38.6            | 106            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 14-010-GW-1 | 179                    | < 5.0    | 32      | 0.21      | NR      |

**LEGEND**

WR1 - Composite of subsamples WR1A, 1B, 1C, and 2.  
BACKGROUND - From Tail Holt (14-010-SS-1).

GW1 - Adit discharge at portal.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Cumberland  
Legal Description: T 16N R 20E  
Mining District: Warm Springs  
Latitude: N 47° 10' 58"  
Longitude: W 109° 12' 30"  
Land Status: Private  
Quad: Judith Peak  
Inspectors: Bullock, S. Babits  
Organization: Pioneer Technical Services, Inc.

County: Fergus  
Section(s): NE 1/4, NE 1/4, Sec. 5  
Mine Type: Hardrock/Ag. Au  
Primary Drainage: Maiden Creek  
USGS Code: 10040204  
Secondary Drainage: Spotted Horse Creek  
Date Investigated: September 11, 1993  
P.A. # 14-017

- The volume of tailings associated with this site was estimated to be approximately 1,220 cubic yards. The following elements were elevated at least three times background:

|                               |                       |
|-------------------------------|-----------------------|
| Arsenic: 129 to 601 mg/kg     | Nickel: 67.4 mg/kg    |
| Copper: 46 mg/kg              | Lead: 163 mg/kg       |
| Mercury: 2.53J to 39.2J mg/kg | Antimony: 17.7J mg/kg |
| Zinc: 347 to 2,170 mg/kg      |                       |
- The volume of waste rock associated with this site was estimated to be approximately 2,935 cubic yards. The following elements were elevated at least three times background:

|                           |                            |
|---------------------------|----------------------------|
| Arsenic: 154 mg/kg        | Manganese: 16,600 mg/kg    |
| Cadmium: 5 to 9 mg/kg     | Lead: 1,190 to 1,270 mg/kg |
| Copper: 61.4 to 384 mg/kg | Zinc: 1,090 to 6,450 mg/kg |
| Mercury: 0.275J mg/kg     |                            |
- There were no adit discharges, seeps, or springs observed at this site during the investigation.
- Spotted Horse Creek flowed directly through the site, and surface water and sediment samples were collected both upstream and downstream from the site. No MCLs were exceeded in either of the samples; however, the chronic aquatic life criteria for mercury was exceeded in both upstream and downstream samples. The chronic aquatic life criteria for lead and iron were exceeded in the upstream sample.
- An observed release to Spotted Horse Creek (sediment) was documented for mercury which was directly attributable to the site.
- Potentially hazardous mine openings associated with this site included two open adits and a large glory hole with a 100 foot tall highwall.

**Cumberland PA# 14-017**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 09/11/93**

| SOLID MATRIX ANALYSES |            |                              |            |            |            |            |            |            |            |            |            |            |            |                 |
|-----------------------|------------|------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| Metals in soils       |            | Results per dry weight basis |            |            |            |            |            |            |            |            |            |            |            |                 |
| FIELD ID              | As (mg/Kg) | Ba (mg/Kg)                   | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 14-017-SE-1           | 78.8       | 253                          | 1.0 U      | 2.08       | 4.55       | 7.86       | 13800      | 0.566 J    | 305        | 6.18       | 53.9       | 6.85 UJ    | 208        | NR              |
| 14-017-SE-2           | 29.8       | 157                          | 1.2 U      | 2.67       | 3.68       | 6.5        | 10100      | 0.123 J    | 502        | 3.6        | 30.6       | 8.02 UJ    | 73.3       | NR              |
| 14-017-TP-1           | 129        | 210                          | 0.8 U      | 2.65       | 5.22       | 7.52       | 8130       | 2.53 J     | 233        | 14.3       | 19.6       | 5.55 UJ    | 347        | 2.55            |
| 14-017-TP-2           | 601        | 627                          | 1.3 U      | 13.4       | 22.6       | 46         | 33500      | 39.2 J     | 1070       | 67.4       | 163        | 17.7 J     | 2170       | 1.57            |
| 14-017-WR-1           | 86.9       | 281                          | 9.5        | 4.48       | 0.96 U     | 61.4       | 16900      | 0.275 J    | 4390       | 8.61       | 1270       | 4.87 UJ    | 1090       | NR              |
| 14-017-WR-2           | 154        | 49.3                         | 5.2        | 9.12       | 15.1       | 384        | 56500      | 0.03 U     | 16600      | 31.2       | 1190       | 6.4 UJ     | 6450       | NR              |
| BACKGROUND            | 31.8       | 226                          | 0.8 U      | 6.41       | 8.08       | 14.1       | 20700      | 0.039 J    | 3060       | 12         | 45.5       | 5.67 UJ    | 107        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

| Acid/Base Accounting |                |                                |                          |                                  |                  |                  |                  |                                  |                                  |
|----------------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| FIELD ID             | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
| 14-017-TP-1          | <0.01          | 0                              | 317                      | 317                              | <0.01            | 0.01             | 0.01             | 0.31                             | 317                              |
| 14-017-TP-1          | <0.01          | 0                              | 321                      | 321                              | <0.01            | 0.01             | 0.01             | 0.31                             | 320                              |
| 14-017-TP-2          | 0.03           | 0.94                           | 288                      | 287                              | <0.01            | 0.02             | 0.04             | 0.62                             | 287                              |
| 14-017-WR-1          | 1.01           | 31.6                           | 53.9                     | 22.3                             | 0.05             | 0.59             | 0.37             | 18.4                             | 35.4                             |
| 14-017-WR-2          | 0.62           | 19.4                           | 94                       | 74.6                             | 0.03             | 0.24             | 0.35             | 7.5                              | 86.5                             |

| WATER MATRIX ANALYSES |         |                 |        |       |        |      |      |      |      |        |      |          |      |                                |
|-----------------------|---------|-----------------|--------|-------|--------|------|------|------|------|--------|------|----------|------|--------------------------------|
| Metals in Water       |         | Results in ug/L |        |       |        |      |      |      |      |        |      |          |      | HARDNESS CALC. Zn (mg CaCO3/L) |
| FIELD ID              | As      | Ba              | Cd     | Co    | Cr     | Cu   | Fe   | Hg   | Mn   | Ni     | Pb   | Sb       |      |                                |
| 14-017-SW-1           | 3.08 JX | 115             | 2.57 U | 9.7 U | 6.83 U | 1.7  | 475  | 0.2  | 6.6  | 12.7 U | 2.62 | 30.7 UJX | 17.5 | 103                            |
| 14-017-SW-2           | 2.03 JX | 114             | 2.57 U | 9.7 U | 6.83 U | 2.57 | 1130 | 0.18 | 21.1 | 12.7 U | 2.56 | 30.7 UJX | 15.3 | 55.5                           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

| Wet Chemistry |                        |          |         |           |         |  | Results in mg/l |  |  |  |  |  |  |  |
|---------------|------------------------|----------|---------|-----------|---------|--|-----------------|--|--|--|--|--|--|--|
| FIELD ID      | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |  |                 |  |  |  |  |  |  |  |
| 14-017-SW-1   | 165                    | < 5.0    | 9       | 0.11      | < 0.005 |  |                 |  |  |  |  |  |  |  |
| 14-017-SW-2   | 128                    | < 5.0    | 5       | < 0.05    | 0.008   |  |                 |  |  |  |  |  |  |  |

**LEGEND**

SE1 - Downstream of lower tailings near Spotted Horse well.  
 SE2 - Upstream of pond created by waste rock dump 3 on Spotted Horse well.  
 TP1 - Composite of subsamples TP1A-A and 1B.  
 TP2 - Sample of subsample TP1A-B.  
 WR1 - Composite of subsamples WR1 and 2.  
 WR2 - Composite of subsamples 3A and 3B.  
 BACKGROUND - From the Tail Holt Mine (14-010-SS-1).

SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Flathead Mine Complex  
Legal Description: T 25N R 23W  
Mining District: Hog Heaven  
Latitude: N 47° 55'  
Longitude: W 114° 34'  
Land Status: Private  
Quad: Koffard Ridge  
Inspectors: Bullock, Tuesday, Belanger,  
Flammang, Clark  
Organization: Pioneer Technical Services, Inc.

County: Flathead  
Section(s): Sec. 17 and 18  
Mine Type: Hardrock/Ag, Au, Pb  
Primary Drainage: Sullivan Creek  
USGS Code: 17010212  
Secondary Drainage: Sullivan Creek  
Date Investigated: August 5, 1993  
P.A. # 15-012

- There were approximately 525 cubic yards of tailings on site. The following elements were elevated at least three times background:

|                     |                     |
|---------------------|---------------------|
| Arsenic: 160J mg/kg | Cadmium: 12.2 mg/kg |
| Copper: 348 mg/kg   | Mercury: 1.58 mg/kg |
| Lead: 3,330 mg/kg   | Antimony: 130 mg/kg |
| Zinc: 3,470 mg/kg   |                     |
  
- There were approximately 89,580 cubic yards of waste rock on site. The following elements were elevated at least three times background:

|                               |                              |
|-------------------------------|------------------------------|
| Arsenic: 134J to 3,690J mg/kg | Barium: 1,000 to 2,160 mg/kg |
| Cadmium: 5.94 to 21.3 mg/kg   | Copper: 34 to 5,760 mg/kg    |
| Iron: 139,000 mg/kg           | Mercury: 0.734 to 6.1 mg/kg  |
| Lead: 1,700 to 21,100 mg/kg   | Antimony: 114 to 438 mg/kg   |
| Zinc: 2,030 to 2,070 mg/kg    |                              |
  
- There were three discharging adits on site and none directly entered surface water. One adit was sampled as GW-1 and had a flowrate of approximately 1 gpm, a pH 2.83 and a specific conductance of 2410 umhos/cm. Arsenic, cadmium, nickel, and antimony exceeded MCL/MCLGs in this discharge. There was a pipe at the West Flathead Nine that discharged to the creek. This discharge was sampled as GW-2 and had a flowrate of approximately 25 gpm, a pH 5.8, and a specific conductance of 1880 umhos/cm. No MCL/MCLGs were exceeded in this discharge. The acute aquatic life criteria for zinc as well as the chronic aquatic life criteria for iron, lead, and zinc were exceeded at the pipe discharge.
  
- There was no flowing surface water on site; no surface water samples were collected. A dry creek ran adjacent to tailings. There were observed releases of barium, cadmium, mercury, antimony, and zinc in downstream sediments.
  
- There are ten open adits, five open stopes, numerous hazardous structures, and highwalls on site.



**Flathead Mine PA# 15-012**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/05/93**

## SOLID MATRIX ANALYSES

| SOLID MATRIX ANALYSES   |                |                                |                          |                                  |                  |                  |                  |                                  |                                  |   |            |            |                          |  |
|---|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|---|------------|------------|--------------------------|--|
| Metals in soils   |                | Results per dry weight basis   |                          |                                  |                  |                  |                  |                                  |                                  |   |            |            |                          |  |
| FIELD ID  | As (mg/Kg)     | Ba (mg/Kg)                     | Cd (mg/Kg)               | Co (mg/Kg)                       | Cr (mg/Kg)       | Cu (mg/Kg)       | Fe (mg/Kg)       | Hg (mg/Kg)                       | Mn (mg/Kg)                       | Ni (mg/Kg)                                | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg)               | CYANIDE (mg/Kg)                          |
| 15-012-SE-1   | 20 J           | 262                            | 9.05                     | 13.3                             | 5.52 U           | 21.4             | 11700            | 0.243                            | 1520                             | 10.2 U                                    | 48.1       | 24.8 U     | 1270                     | NR                                       |
| 15-012-SE-2   | 15.4 J         | 70.9                           | 0.54 U                   | 2.03 U                           | 1.43 U           | 26               | 13100            | 0.031                            | 64.3                             | 2.65 U                                    | 27.1       | 6.43 U     | 80                       | NR                                       |
| 15-012-TP-1   | 160 J          | 711                            | 12.2                     | 1.78 U                           | 1.87             | 348              | 15800            | 1.58                             | 3.19                             | 2.32 U                                    | 3330       | 130        | 3470                     | NR                                       |
| 15-012-WR-1   | 310 J          | 1000                           | 5.94                     | 1.96 U                           | 1.38 U           | 116              | 22800            | 1.91                             | 72.5                             | 2.56 U                                    | 3460       | 125        | 2070                     | NR                                       |
| 15-012-WR-2   | 778 J          | 2160                           | 2.85                     | 1.57 U                           | 1.1 U            | 84.7             | 20600            | 6.1                              | 30.7                             | 2.05 U                                    | 16500      | 114        | 201                      | NR                                       |
| 15-012-WR-3   | 134 J          | 89.1                           | 1.12                     | 1.66 U                           | 1.87             | 34               | 13800            | 0.734                            | 92                               | 2.16 U                                    | 1700       | 89.3       | 119                      | NR                                       |
| 15-012-WR-4   | 3690 J         | 82.4                           | 21.3                     | 6.03                             | 1.94             | 5760             | 139000           | 1.84                             | 12.1                             | 5.77                                      | 21100      | 438        | 2030                     | NR                                       |
| BACKGROUND  | 7.17 J         | 283                            | 1.28                     | 4.96                             | 3.23             | 9.38             | 14100            | 0.046                            | 1220                             | 5.12                                      | 20.7       | 5.23 U     | 149                      | NR                                       |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                |                                |                          |                                  |                  |                  |                  |                                  |                                  |   |            |            |                          |  |
| Acid/Base Accounting  |                |                                |                          |                                  |                  |                  |                  |                                  |                                  |   |            |            |                          |  |
| FIELD ID  | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t | Mechanical Analysis and % Coarse Material |            |            |                          | Cation Exchange Capacity milliequiv./100 |
|   |                |                                |                          |                                  |                  |                  |                  |                                  |                                  | % clay                                    | % sand     | % silt     | % Coarse Material (>2mm) |  |
| 15-012-TP-1   | 1.89           | 59.0                           | -3.55                    | -62.6                            | 0.25             | 1.37             | 0.27             | 42.8                             | -46.3                            | 6   | 54         | 40         | 0                        | 0.63                                     |
| 15-012-WR-1   | 3.00           | 93.7                           | -5.49                    | -99.2                            | 0.57             | 1.12             | 1.31             | 35.0                             | -40.5                            |   |            |            |                          |  |
| 15-012-WR-2   | 1.62           | 50.6                           | -2.23                    | -52.8                            | 0.77             | 0.06             | 0.79             | 1.87                             | -4.11                            |   |            |            |                          |  |
| 15-012-WR-3   | 0.86           | 27.0                           | -1.51                    | -28.5                            | 0.35             | 0.30             | 0.21             | 9.37                             | -10.9                            |   |            |            |                          |  |
| 15-012-WR-4DUP  | 25.3           | 791                            | -5.35                    | -796                             | <0.01            | 12.1             | 15.1             | 378                              | -384                             |   |            |            |                          |  |
| 15-012-WR-4   | 25.6           | 798                            | -5.21                    | -803                             | <0.01            | 11.8             | 15.4             | 367                              | -373                             |   |            |            |                          |  |

## WATER MATRIX ANALYSES

| WATER MATRIX ANALYSES   |                        |                 |         |           |         |  |         |          |      |        |        |        |                 |  |
|---|------------------------|-----------------|---------|-----------|---------|--|---------|----------|------|--------|--------|--------|-----------------|--|
| Metals in Water   |                        | Results in ug/L |         |           |         |  |         |          |      |        |        |        | HARDNESS        |  |
| FIELD ID  | As                     | Ba              | Cd      | Co        | Cr      | Cu   | Fe      | Hg       | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) |  |
| 15-012-GW-1   | 102 J                  | 13.9            | 1710    | 187 U     | 6.83 U  | 1170   | 71800 J | 0.310 JX | 6060 | 121    | 826 J  | 73.6   | 62300 J         |  |
| 15-012-GW-2   | 32.6 J                 | 16.5            | 2.57 U  | 9.7       | 7.63    | 1.55 U   | 15100 J | 0.220 JX | 4040 | 12.7 U | 3.79 J | 30.7 U | 793             |  |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                        |                 |         |           |         |  |         |          |      |        |        |        |                 |  |
| Wet Chemistry   |                        | Results in mg/l |         |           |         |  |         | LEGEND   |      |        |        |        |                 |  |
| FIELD ID.   | TOTAL DISSOLVED SOLIDS | CHLORIDE        | SULFATE | NO3/NO2-N | CYANIDE | SE1 - Sullivan Ck. downstream from Flathead & W. Flathead areas<br>SE2 - Sullivan Ck. upstream from the W. Flathead area<br>TP1 - Composite of subsamples TP1A, 1B, 1C, 2A, 2B, and 2C.<br>WR1 - Composite of subsamples WR1A, 1B, 1C, 2A, 2B, and 2C.<br>WR2 - Composite of subsamples WR3A, 4A, 5A, and 5B.<br>WR3 - Composite of subsamples WR6, 7A, 7B, 8, and 12B.<br>WR4 - Composite of subsamples WR9, 10A, and 11.<br>BACKGROUND - From the Flathead Mine (15-012-SS-1). |         |          |      |        |        |        |                 |  |
| 15-012-GW-1   | 2200                   | 7.7             | 1320    | 1.9       | NR      | GW1 - Flathead Mine western adit assoc. w/ WR2<br>GW2 - West Flathead Mine from pipe at mine.  |         |          |      |        |        |        |                 |  |
| 15-012-GW-2   | 292                    | < 5.0           | 162     | < 0.05    | NR      |  |         |          |      |        |        |        |                 |  |

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Elk Creek Corundum</u>             | County: <u>Gallatin</u>                             |
| Legal Description: <u>T 3 S R 3 E</u>                 | Section(s): <u>NE 1/2, Sec. 22; NW 1/2, Sec. 23</u> |
| Mining District: <u>Bozeman</u>                       | Mine Type: <u>Hardrock/Corundum</u>                 |
| Latitude: <u>N 45° 33' 48"</u>                        | Primary Drainage: <u>Elk Creek</u>                  |
| Longitude: <u>W 111° 20' 00"</u>                      | USGS Code: <u>10020008</u>                          |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Elk Creek</u>                |
| Quad: <u>Ruby Mountain</u>                            | Date Investigated: <u>August 12, 1993</u>           |
| Inspectors: <u>Babits, Flammang, Lasher</u>           | P.A. # <u>16-013</u>                                |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no tailings on site.
- There was approximately 7,150 cubic yards of partially covered waste rock on site. The following were elevated at least three times background:  
Cadmium: 2J mg/kg  
Copper: 212 mg/kg  
Mercury: 0.234 mg/kg
- There were no discharging adits, filled shafts, seeps, or springs identified at the site during the investigation.
- The East Fork of Elk Creek flowed along the toe of the waste rock dump at the site. The chronic aquatic life criteria for mercury was exceeded in both upstream and downstream samples. The chronic aquatic life criteria for lead was exceeded in the downstream sample.
- Two potentially hazardous open shafts were identified at the site.

**Elk Creek Corundum PA# 16-013**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/12/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 16-018-SE-2 | 5 U        | 31.8       | 0.5 U      | 3.4        | 7.4        | 9.9        | 5170       | 0.028 U    | 99.1       | 10         | 8 U        | 6 U        | 19         | NR              |
| 16-013-SE-1 | 5.33 U     | 31.8 J     | 0.58 UJ    | 3.33       | 8.63       | 7.84       | 4110       | 0.032 U    | 80.8       | 7.55       | 9.14 U     | 6.94 UJ    | 12         | NR              |
| 16-013-WR-1 | 4 U        | 267        | 2 J        | 30.7       | 33.4       | 212        | 32100      | 0.234      | 309        | 52         | 7 U        | 5 U        | 64         | NR              |
| BACKGROUND  | 8.47       | 156 J      | 0.43 UJ    | 14.5       | 32.2       | 70.3       | 16600      | 0.027 U    | 382        | 33.6       | 16.1       | 5.18 UJ    | 46.4       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID       | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|----------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 16-013-WR-1    | <0.01          | 0.00                           | 17.0                    | 17.0                             | <0.01            | <0.01            | 0.01             | 0.00                             | 17.0                             |
| 16-013-WR-1DUP | 0.01           | 0.31                           | 17.8                    | 17.5                             | <0.01            | <0.01            | 0.01             | 0.00                             | 17.8                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co    | Cr     | Cu     | Fe  | Hg    | Mn   | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|------|--------|-------|--------|--------|-----|-------|------|--------|------|--------|-----------------|----------------|
| 16-013-SW-1 | 2.4  | 51.1 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 339 | 0.120 | 11.3 | 12.7 U | 0.85 | 30.7 U | 7.57 U          | 46.6           |
| 16-013-SW-2 | 2.71 | 51   | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 360 | 0.120 | 13.1 | 12.7 U | 1.74 | 30.7 U | 7.57 U          | 47             |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 16-013-SW-1 | 117                    | < 5.0    | < 5     | 0.06      | NR      |
| 16-013-SW-2 | 116                    | 13.0     | < 5     | 0.06      | NR      |

**LEGEND**

SE1 - 100 feet upgradient of waste rock dump 6 in East Fork Elk Creek. SW1 - Same as sample SE1.  
SE2 - At toe of waste rock dump 6 in East Fork Elk Creek. SW2 - Same as sample SE2.  
BACKGROUND - On saddle west of shaft #1. From the Thurper Mica Mine (16-015-SS1-)

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Thumper Mica</u>                   | County: <u>Gallatin</u>                           |
| Legal Description: <u>T 4 S R 5 E</u>                 | Section(s): <u>NE 1/4, Sec. 30</u>                |
| Mining District: <u>Bozeman</u>                       | Mine Type: <u>Hardrock/Mica</u>                   |
| Latitude: <u>N 45° 27' 41"</u>                        | Primary Drainage: <u>Gallatin River</u>           |
| Longitude: <u>W 111° 08' 50"</u>                      | USGS Code: <u>10020008</u>                        |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Mica Creek/Squaw Creek</u> |
| Quad: <u>Garnet Mountain</u>                          | Date Investigated: <u>August 12, 1993</u>         |
| Inspectors: <u>Bullock, Belanger, Clark</u>           | P.A. # <u>16-015</u>                              |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 5,000 cubic yards; however, no elements were elevated significantly above background concentrations.
- No discharging adits were observed at the site during the investigation; however, a groundwater seep was located adjacent to WR-1. This seep was sampled as GW-1 and discharged at a rate of approximately 3 gpm, with a pH of 9.3 and a specific conductance of 80 umhos/cm. No MCLs were exceeded in the seep; however, acute and chronic aquatic life criteria were exceeded for copper, and the chronic aquatic life criteria for lead was exceeded.
- An unnamed tributary to Mica Creek was located east of the site; however, the stream was not sampled due to the lack of a defined runoff pathway from the site and the low metals concentrations in the potential source.
- One potentially hazardous adit opening and two highwalls were identified at the site.



**Thumper Mine PA# 16-015**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/12/93**

## SOLID MATRIX ANALYSES

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 16-015-WR-1 | 4.99 U        | 3.37 J        | 0.54 UJ       | 2.05 U        | 1.45 U        | 7.27          | 1450          | 0.025 U       | 37.8          | 10.5          | 11.3          | 6.49 UJ       | 17.5          | NR                 |
| BACKGROUND  | 8.47          | 156 J         | 0.43 UJ       | 14.5          | 32.2          | 70.3          | 16600         | 0.027 U       | 382           | 33.6          | 16.1          | 5.18 UJ       | 46.4          | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

## Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 16-015-WR-1 | <0.01          | 0.00                           | 0.24                     | 0.24                             | <0.01            | <0.01            | 0.01             | 0.00                             | 0.24                             |

## WATER MATRIX ANALYSES

**Metals in Water**  
**Results in ug/L**

| FIELD ID    | RESULTS IN mg/L |      |        |       |        |       |     |         |      |    |      |        | HARDNESS CALC.  |    |
|-------------|-----------------|------|--------|-------|--------|-------|-----|---------|------|----|------|--------|-----------------|----|
|             | As              | Ba   | Cd     | Co    | Cr     | Cu    | Fe  | Hg      | Mn   | Ni | Pb   | Sb     | Zn (mg CaCO3/L) |    |
| 16-015-GW-1 | 1.9             | 18.1 | 2.57 U | 9.7 U | 6.83 U | 6.9 J | 367 | 0.120 U | 20.1 | 16 | 1.61 | 30.7 U | 12.7            | 30 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD<br>I.D. | TOTAL<br>DISSOLVED<br>SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|---------------|------------------------------|----------|---------|-----------|---------|
| 16-015-GW-1   | 68                           | 7.0      | 7       | 0.15      | NR      |

## LEGEND

WR1 - Composite of subsamples WR1A and 1B.  
BACKGROUND - From Thumper Mica (16-015-SS-1).

GW1 - Seepage from waste rock dump 1.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Karst Asbestos</u>                 | County: <u>Gallatin</u>                    |
| Legal Description: T <u>5S</u> R <u>4E</u>            | Section(s): <u>NW 1/4, SW 1/4, Sec. 36</u> |
| Mining District: <u>West Gallatin</u>                 | Mine Type: <u>Hardrock/Asbestos</u>        |
| Latitude: <u>N 45° 21' 25"</u>                        | Primary Drainage: <u>Gallatin River</u>    |
| Longitude: <u>W 111° 10' 60"</u>                      | USGS Code: <u>10020008</u>                 |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Gallatin River</u>  |
| Quad: <u>Hidden Lake</u>                              | Date Investigated: <u>August 13, 1993</u>  |
| Inspectors: <u>Babits, Flammang, Lasher</u>           | P.A. # <u>16-018</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- An asbestos mine and washing mill were located at this site. Anthophyllite asbestos was detected on-site.
- An unnamed tributary to the Gallatin River flowed adjacent to the washing mill. An observed release to the tributary was documented for asbestos. However, the MCL for asbestos was not exceeded; and no acute or chronic aquatic life criteria exist for asbestos. Asbestos was not detected in upstream or downstream sediment samples.

**Karst Asbestos PA# 16-018**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/13/93**

**SOLID MATRIX ANALYSES**

| FIELD ID  | Homogeneity   | Color | Texture  | Sample Description | Analysis | Asbestos Type Identified | % Anthophyllite (Conc. on area basis) | % Total Asbestos (Conc. on area basis) | % Cellulose | % Other Non-Fibrous (Range) |
|---|---------------|-------|----------|--------------------|----------|--------------------------|---------------------------------------|--|-------------|-----------------------------|
| 16-018-SE-1*  | Heterogeneous | Brown | Granular | Soil               | PLM      | -                        | NR                                    | ND                                     | Trace       | 90-100                      |
| 16-018-SE-2*  | Heterogeneous | Brown | Granular | Soil               | PLM      | -                        | NR                                    | ND                                     | Trace       | 90-100                      |
| 16-018-WR-1*  | Heterogeneous | Brown | Granular | Soil               | PLM      | 100% Anthro.             | 5-10                                  | 5-10                                   | Trace       | 90-100                      |
| 16-018-WR-2*  | Heterogeneous | Brown | Granular | Soil               | PLM      | 100% Anthro.             | 5-10                                  | 5-10                                   | Trace       | 90-100                      |
| NR - Not Requested; ND - Not Detected; Trace = <1%<br>* Data obtained from DATACHEM Laboratories. |               |       |          |                    |          |                          |                                       |  |             |                             |
| Karst Mine**  | Homogeneous   | Grey  | Fibrous  | -                  | PLM      | 100% Anthro.             | -                                     | NR                                     | -           | 0                           |
| Karst Mill**  | Homogeneous   | Grey  | Fibrous  | -                  | PLM      | 95% Anthro.<br>5% OTHER  | -                                     | NR                                     | -           | 5                           |

\*\* Data obtained from EMSL.

**WATER MATRIX ANALYSES**

| FIELD ID     | Chrysotile (MFL) | Grunerite (MFL) | Riebeckite (MFL) | Actinolite-Tremolite (MFL) | Anthrophyllite (MFL) | Total Fibers Detected | Total Asbestos Conc. (MFL) | Limit of Detection (MFL) |
|--------------|------------------|-----------------|------------------|----------------------------|----------------------|-----------------------|----------------------------|--------------------------|
| 16-018-SW-1* | <LOD             | <LOD            | <LOD             | <LOD                       | <LOD                 | 0                     | <LOD                       | 0.09                     |
| 16-018-SW-2* | <LOD             | <LOD            | <LOD             | 0.38                       | 0.38                 | 4                     | 0.76                       | 0.19                     |

LOD - Less than limit of detection.

MFL - Millions of fibers per liter.

**LEGEND**

SE1 - 200' upgradient of mill in unnamed tributary.

SE2 - 200' downgradient of mill in unnamed tributary.

WR1 - In waste rock pile in front of adit #1.

WR2 - In downgradient washing mill in waste rock.

SW1 - Same location as SE1. Sample also contained asbestos fiber <10um long and many non-asbestos fibers.

SW2 - Same location as SE2.

NOTE: EPA regulations specify that drinking water must contain less than 7MFL asbestos.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |   |
|--|---|
| Mine/Site Name: <u>Alps</u>                      | County: <u>Granite</u>                          |
| Legal Description: T <u>10N</u> R <u>16W</u>     | Section(s): <u>SE 1/4, Sec. 27</u>              |
| Mining District: <u>Alps</u>                     | Mine Type: <u>Hardrock/Unknown</u>              |
| Latitude: <u>N 46° 35' 35"</u>                   | Primary Drainage: <u>Brewster Creek</u>         |
| Longitude: <u>W 113° 35' 10"</u>                 | USGS Code: <u>17010202</u>                      |
| Land Status: <u>Private</u>                      | Secondary Drainage: <u>Unnamed tributary to</u> |
| Quad: <u>Spink Point</u>                         | <u>Brewster Creek</u>                           |
| Inspectors: <u>Babits/Pierson</u>                | Date Investigated: <u>June 30, 1993</u>         |
| Organization: <u>Pioneer Technical Services,</u> | P.A. # <u>20-065</u>                            |
| <u>Inc./Thomas, Dean and Hoskins, Inc.</u>       |   |

There were no tailings on site.

- There were approximately 14,023 cubic yards of uncovered waste rock on site. The following were elevated at least three times background:  
Arsenic: 63JX mg/kg                      Iron: 99,700J mg/kg  
Mercury: 0.355 mg/kg
- There was one discharging adit that did not have a surface route to water. The sample from the adit had a pH measured at 4.13. There were no MCLs or MCLGs exceeded.
- The nearest surface water was approximately 1,000 feet from the site. No surface water or sediment samples were collected.
- There was one open shaft and two open adits on site.



**Alps PA# 20-065**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 06/30/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 20-065-WR-1 | 51 JX      | 287        | 0.4 U      | 1 U        | 0.8 U      | 4.6        | 29000 J    | 0.159      | 140 J      | 2 J        | 6 J        | 3 U        | 10 J       | NR              |
| 20-065-WR-2 | 63 JX      | 961        | 0.4 U      | 2.6 J      | 1.6 J      | 7.9        | 99700 J    | 0.355      | 1390 J     | 12 J       | 16 J       | 3 U        | 16 J       | NR              |
| BACKGROUND  | 19 JX      | 415        | 0.6 U      | 2.4 J      | 4.6 J      | 5.6        | 17300 J    | 0.067      | 985 J      | 8 J        | 12 J       | 4 U        | 26 J       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 20-065-WR-1 | 0.14           | 4.37                           | -0.5                    | -4.8                             | 0.11             | <0.01            | 0.03             | 0                                | -0.45                            |
| 20-065-WR-2 | 0.52           | 16.2                           | 1.01                    | -15                              | 0.07             | 0.06             | 0.39             | 1.87                             | -0.87                            |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba      | Cd     | Co    | Cr     | Cu     | Fe   | Hg      | Mn   | Ni     | Pb   | Sb     | HARDNESS CALC. Zn (mg CaCO3/L) |
|-------------|--------|---------|--------|-------|--------|--------|------|---------|------|--------|------|--------|--------------------------------|
| 20-065-GW-1 | 4.22 J | 65.2 JX | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 4930 | 0.038 U | 1130 | 12.7 U | 1.36 | 30.7 U | 14.1 40.3                      |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID.   | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 20-065-GW-1 | 109                    | < 5.0    | 62      | < 0.05    | NR      |

**LEGEND**

WR1 - Composite of subsamples WR1 and 2.

WR2 - Sample of the subsample WR4.

BACKGROUND - Apprx. 100 feet above waste rock dump 4.  
From the Alps Mine (20-065-SS-1).

GW1 - Discharging adit at waste rock dump 1.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Silver King</u>                    | County: <u>Granite</u>                  |
| Legal Description: <u>T 6N R 15W</u>                  | Section(s): <u>Sec. 5</u>               |
| Mining District: <u>Antelope Creek</u>                | Mine Type: <u>Hardrock/Ag. Au</u>       |
| Latitude: <u>N 46° 18' 05"</u>                        | Primary Drainage: <u>Rock Creek</u>     |
| Longitude: <u>W 113° 30' 00"</u>                      | USGS Code: <u>17010202</u>              |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Sluice Gulch</u> |
| Quad: <u>Cornish Gulch</u>                            | Date Investigated: <u>June 30, 1993</u> |
| Inspectors: <u>Bullock, Flammang, Clark</u>           | P.A. # <u>20-186</u>                    |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no mill tailings observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 29,255 cubic yards. The following elements were elevated at least three times background:

|                                |                             |
|--------------------------------|-----------------------------|
| Arsenic: 444JX to 575JX mg/kg  | Manganese: 1,440 mg/kg      |
| Copper: 122 to 287 mg/kg       | Lead: 43J to 137J mg/kg     |
| Iron: 44,500J to 47,600J mg/kg | Antimony: 80J to 269J mg/kg |
| Mercury: 1.47 to 4.9 mg/kg     |                             |
- There was one flowing adit associated with the site. No MCLs were exceeded in the adit discharge; however, acute and chronic aquatic life criteria were exceeded for copper.
- Sluice Gulch Creek was flowing adjacent to the site on the west side during the investigation, and upstream and downstream surface water samples were collected. No observed releases were documented and MCL/MCLGs were not exceeded. No aquatic life criteria were exceeded that were attributable to the site.
- Potentially hazardous mine openings associated with the site included five open adits, one collapsed adit, and an open stope. Another adit had been secured by a metal door.

**Silver King PA# 20-186**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/30/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 20-186-SP-1 | 575 JX     | 465        | 0.5 U      | 2.2 J      | 4.4 J      | 122        | 22900 J    | 1.47       | 365 J      | 6 J        | 43 J       | 80 J       | 23 J       | NR              |
| 20-186-WR-1 | 444 JX     | 214        | 0.6 U      | 6.4 J      | 6.8 J      | 287        | 44500 J    | 2.27       | 1440 J     | 13 J       | 89 J       | 99 J       | 56 J       | NR              |
| 20-186-WR-4 | 450 JX     | 718        | 0.6 U      | 6.9 J      | 12.7 J     | 185        | 47600 J    | 4.9        | 407 J      | 17 J       | 137 J      | 269 J      | 42 J       | NR              |
| BACKGROUND  | 11 J       | 267        | 1.7        | 11         | 8.7        | 7.8        | 12800      | 0.08 JX    | 250        | 9          | 15         | 5 UJ       | 62         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 20-186-SP-1 | 0.11           | 3.44                           | 2.08                    | -1.4                             | 0.05             | 0.02             | 0.04             | 0.62                             | 1.46                             |
| 20-186-WR-1 | 3.22           | 101                            | 46.7                    | -54                              | 0.54             | 2.13             | 0.55             | 66.5                             | -19.8                            |
| 20-186-WR-4 | 0.4            | 12.5                           | 0.84                    | -12                              | 0.38             | <0.01            | 0.03             | 0                                | 0.84                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba      | Cd     | Co    | Cr     | Cu     | Fe  | Hg      | Mn   | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|---------|--------|-------|--------|--------|-----|---------|------|--------|------|--------|-----------------|----------------|
| 20-186-GW-1 | 6.95 J | 7.83 JX | 2.57 U | 9.7 U | 6.83 U | 197 J  | 273 | 0.038 U | 901  | 12.7 U | 1 U  | 30.7 U | 86.9            | 284            |
| 20-186-SW-1 | 15.1 J | 58.2 JX | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 428 | 0.038 U | 14.8 | 12.7 U | 1.64 | 30.7 U | 7.57 U          | 141            |
| 20-186-SW-2 | 14.7 J | 56.4 JX | 2.7 J  | 9.7 U | 7.97   | 1.55 U | 361 | 0.038 U | 10.4 | 12.7 U | 1 U  | 30.7 U | 7.57 U          | 140            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 20-186-GW-1 | 402                    | 8.7      | 144     | 0.3       | NR      |
| 20-186-SW-1 | 182                    | < 5.0    | 10      | 0.12      | NR      |
| 20-186-SW-2 | 160                    | 7.7      | 10      | 0.12      | NR      |

**LEGEND**

SP1 - Composite of subsamples SP1A and 1B.  
WR1 - Composite of subsamples WR1A, 1B, 2, and 3.  
WR4 - Composite of subsamples WR4 and 5.  
BACKGROUND - From the Montana Prince Mine (41-004-SS-1).

GW1 - End of pipe pumping water from adit #1.  
SW1 - 100' upstream of adit #1.  
SW2 - 100' downstream of last structure to the North.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Lori No. 13  
Legal Description: T 6 N R 15 W  
Mining District: Antelope Creek  
Latitude: N 46° 18' 17"  
Longitude: W 113° 29' 00"  
Land Status: Public  
Quad: Antelope Creek  
Inspectors: Babits/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Granite  
Section(s): SE 1/4, NW 1/4, Sec. 4  
Mine Type: Hardrock/Unknown  
Primary Drainage: Rock Creek  
USGS Code: 17010202  
Secondary Drainage: Sluice Gulch  
Date Investigated: September 10, 1993  
P.A. # 20-191

- No mill tailings were identified at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 700 cubic yards. The waste rock pile was well vegetated; consequently, no samples were collected.
- No discharging adits, filled shafts, seeps, or springs were observed at the site during the investigation; and no surface water was identified on or near the site, the nearest surface water was located approximately 800 feet south of the site. No groundwater or surface water samples were collected.
- One potentially hazardous open adit was identified at the site.





**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |  |
|--|--|
| Mine/Site Name: <u>Ant</u><br>Legal Description: <u>T 6 N R 15 W</u><br>Mining District: <u>Antelope Creek</u><br>Latitude: <u>N 46° 14' 08" or 09"</u><br>Longitude: <u>W 113° 27' 12"</u><br>Land Status: <u>Private</u><br>Quad: <u>Potato Lakes</u><br>Inspectors: <u>M. Babits, S. Babits/Pierson</u><br>Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> | County: <u>Granite</u><br>Section(s): <u>NE 1/4, NE 1/4, Sec. 34</u><br>Mine Type: <u>Hardrock/Unknown</u><br>Primary Drainage: <u>Rock Creek</u><br>USGS Code: <u>17010202</u><br>Secondary Drainage: <u>South Fork Antelope Creek</u><br>Date Investigated: <u>September 9, 1993</u><br>P.A. # <u>20-194</u> |
|--|--|

- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 2,300 cubic yards. The following elements were elevated at least three times background:

|                      |                      |
|----------------------|----------------------|
| Arsenic: 1,060 mg/kg | Barium: 3,420J mg/kg |
| Copper: 50.6J mg/kg  | Iron: 67,200 mg/kg   |
| Mercury: 0.312 mg/kg |                      |
- One adit which contained water was identified at the site; however, the water was not flowing. The pH measurement in the ponded water was 2.9. No MCLs were exceeded in the water; however, the chronic aquatic life criteria for iron was exceeded.
- No surface water was identified on or adjacent to the site. The nearest surface water, South Fork of Antelope Creek, was located approximately 450 feet east of the site. No surface water or sediment samples were collected.
- Four potentially hazardous open adits were identified at the site.

**Ant PA# 20-194**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 09/09/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
 Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 20-194-WR-1 | 1060       | 3420 J     | 0.6 U      | 2.13 U     | 4.65       | 50.6 J     | 67200      | 0.312      | 321 J      | 2.78 U     | 25.2       | 11.4 J     | 26.9       | NR              |
| BACKGROUND  | 11 J       | 267        | 1.7        | 11         | 8.7        | 7.8        | 12800      | 0.08 JX    | 250        | 9          | 15         | 5 UJ       | 62         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 20-194-WR-1 | 0.63           | 19.7                           | 3.94                    | -16                              | 0.01             | 0.07             | 0.55             | 2.19                             | 1.75                             |

**WATER MATRIX ANALYSES**

Metals in Water  
 Results in ug/L

| FIELD ID    | As  | Ba     | Cd     | Co    | Cr     | Cu    | Fe   | Hg       | Mn  | Ni      | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|-----|--------|--------|-------|--------|-------|------|----------|-----|---------|------|--------|-----------------|----------------|
| 20-194-SW-1 | 3.5 | 2.01 U | 2.57 U | 9.7 U | 6.83 U | 3.1 J | 1700 | 0.12 UJX | 604 | 19.6 JX | 2.83 | 30.7 U | 13.7 J          | 639            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
 Results in mg/l

| FIELD<br>I.D. | TOTAL<br>DISSOLVED<br>SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|---------------|------------------------------|----------|---------|-----------|---------|
| 20-194-SW-1   | 950                          | < 5.0    | 519     | 0.63      | NR      |

**LEGEND**

WR1 - Composite of subsamples WR1A and 1B.  
 BACKGROUND - From Montana Prince (41-004-SS-1).

SW1 - Adit discharge at waste rock dump 1.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Combination Millsite</u>           | County: <u>Granite</u>                                   |
| Legal Description: T <u>8N</u> R <u>14W</u>           | Section(s): <u>SE 1/4, E 1/2, Sec. 7</u>                 |
| Mining District: <u>Combination</u>                   | Mine Type: <u>Hardrock/Cu, Pb, Zn, Ag, Au</u>            |
| Latitude: <u>N 46° 27' 30"</u>                        | Primary Drainage: <u>Flint Creek</u>                     |
| Longitude: <u>W 113° 23' 30"</u>                      | USGS Code: <u>17010202</u>                               |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>South Fork Lower Willow Creek</u> |
| Quad: <u>Black Pine Ridge</u>                         | Date Investigated: <u>July 21, 1993</u>                  |
| Inspectors: <u>Tuesday, Belanger, Clark</u>           | P.A. # <u>20-009</u>                                     |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- The mill tailings associated with this site were not impounded but were in the floodplains of both Mill Creek and South Fork Lower Willow Creek; the tailings extended one half mile downstream from the site in the S. F. Lower Willow Creek floodplain. The volume of these tailings were estimated at 69,500 cubic yards and were 20% revegetated. Some reclamation/ revegetation work was done by Inspiration Mining on the floodplain tailings. The following elements were elevated at least three times background:

|                       |                     |
|-----------------------|---------------------|
| Arsenic : 2,050 mg/kg | Barium: 1,100 mg/kg |
| Cadmium: 89.5 mg/kg   | Copper: 9,620 mg/kg |
| Mercury: 306J mg/kg   | Lead: 14,400 mg/kg  |
| Antimony: 2,210 mg/kg | Zinc: 584 mg/kg     |
- There was no waste rock associated with this site.
- An observed release to surface water (S. F. Lower Willow Creek) was documented in sediments for arsenic, cadmium, copper, mercury, lead, antimony, and zinc, and in water samples for copper and lead. No exceedances of drinking water standards were found in either creek.
- Aquatic life criteria for copper and lead (acute) and copper, lead, and mercury (chronic) were exceeded in downstream samples; criteria for copper (acute) and copper and lead (chronic) were also exceeded in upstream samples. A possible upstream contaminant source (e.g. Combination Mine) may be responsible for the exceedances.
- The old mill foundation could be hazardous. A vat of unknown contents (15 cubic yards), and a pile of white powder may be hazardous materials.
- No adit discharges, springs or seeps were observed at the site.



**Combination PA# 20-009**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 07/21/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 20-009-SE-1 | 311        | 105        | 6.9        | 6.01       | 1.74       | 830        | 10800      | 52.3 J     | 372 J      | 2.8 U      | 1550       | 337        | 241        | NR              |
| 20-009-SE-2 | 37.1       | 286        | 2.4        | 6.5        | 10.2       | 250        | 13400      | 1.07 J     | 605 J      | 13.7       | 91.2       | 27.4       | 80.1       | NR              |
| 20-009-SE-3 | 10.2       | 94.9       | 0.9        | 2.93       | 2.45       | 18.8       | 3710       | 0.083 J    | 206 J      | 2.49 U     | 21         | 6.07       | 32.6       | NR              |
| 20-009-TP-1 | 2050       | 1100       | 89.5       | 3.33       | 4.51       | 9620       | 28300      | 306 J      | 462 J      | 3.29       | 14400      | 2210       | 584        | NR              |
| BACKGROUND  | 76.3       | 329        | 1.6        | 6.18       | 6.06       | 116        | 11700      | 1.33 J     | 1530 J     | 6.77       | 85.8       | 33.3       | 47.4       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 20-009-TP-1 | 0.08           | 2.5                            | 1.81                    | -0.7                             | 0.06             | <0.01            | 0.02             | 0                                | 1.81                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu   | Fe   | Hg      | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|--------|-------|--------|------|------|---------|------|--------|--------|--------|-----------------|----------------|
| 20-009-SW-1 | 3.25   | 78.5 | 2.57 U | 9.7 U | 6.83 U | 21.9 | 410  | 0.081   | 20.9 | 12.7 U | 9.93   | 30.7 U | 7.57 U          | 15.1           |
| 20-009-SW-2 | 2.4    | 69.7 | 2.57 U | 9.7 U | 6.83 U | 17.2 | 1280 | 0.038 U | 17.4 | 12.7 U | 3.3    | 30.7 U | 7.57 U          | 21             |
| 20-009-SW-3 | 1.69 U | 78.2 | 2.57 U | 9.7 U | 6.83 U | 1.9  | 264  | 0.038 U | 15.6 | 12.7 U | 1.55 U | 30.7 U | 7.57 U          | 14.3           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 20-009-SW-1 | 89                     | < 5.0    | 7       | 0.16      | NR      |
| 20-009-SW-2 | 112                    | < 5.0    | 14      | < 0.05    | NR      |
| 20-009-SW-3 | 95                     | < 5.0    | 6       | 0.18      | NR      |

**LEGEND**

SE1 - Downstream from junction of Mill Creek and Willow Creek.  
SE2 - Upstream in Mill Creek.  
SE3 - Upstream in S. Fork Lower Willow Creek.  
TP1 - Composite of subsamples TP1A1, 1B2, 1C1, and 1D1.  
BACKGROUND - From the Combination Mine (20-009-SS-1).

SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.  
SW3 - Same as sample SE3.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Forest Rose  
Legal Description: T 9N R 12W  
Mining District: Dunkleburg  
Latitude: N 46° 30' 29"  
Longitude: W 113° 05' 21"  
Land Status: Private/Public  
Quad: Dunkleburg Creek  
Inspectors: Bullock, Flammang, Clark  
Organization: Pioneer Technical Services, Inc.

County: Granite  
Section(s): NW 1/4, SE 1/4, Sec. 22  
Mine Type: Hardrock/Pb, Zn, Ag  
Primary Drainage: Clark Fork River  
USGS Code: 17010202  
Secondary Drainage: Dunkleburg Creek  
Date Investigated: June 29, 1993  
P.A. # 20-004

- The volume of tailings associated with this site was estimated to be approximately 23,000 cubic yards. The dam at the lower impoundment failed just prior to this investigation. The following elements were elevated at least three times background:

|                                  |                               |
|----------------------------------|-------------------------------|
| Arsenic: 330JX to 444JX mg/kg    | Mercury: 0.342 to 0.377 mg/kg |
| Cadmium: 58.2J to 143J mg/kg     | Lead: 690J to 6,8810J mg/kg   |
| Copper: 404 to 563 mg/kg         | Antimony: 28J to 49J mg/kg    |
| Iron: 109,000J to 113,000J mg/kg | Zinc: 6,590J to 16,800J mg/kg |
- The volume of waste rock associated with this site was estimated to be approximately 8,000 cubic yards. The following elements were elevated at least three times background:

|                               |                               |
|-------------------------------|-------------------------------|
| Arsenic: 227 to 801JX mg/kg   | Mercury: 0.648J to 2.93 mg/kg |
| Cadmium: 3.2J to 477J mg/kg   | Lead: 242J to 60,400J mg/kg   |
| Copper: 208 to 1,770 mg/kg    | Antimony: 24J to 470J mg/kg   |
| Iron: 75,700 to 164,000 mg/kg | Zinc: 2,840J to 51,500J mg/kg |
- One discharging adit was identified at the site. No MCLs were exceeded in the adit discharge; however, acute and chronic aquatic life criteria were exceeded for zinc, and the chronic aquatic life criteria for cadmium were exceeded in the adit discharge.
- Three surface water and sediment samples were collected at the site from Dunkleburg Creek. One sample was collected from the toe of WR-1, to determine potential impacts from the waste rock and samples were collected both upstream and downstream from the site, proper. Observed releases to Dunkleburg Creek were documented for arsenic, copper, iron, and lead. The MCL/MCLG for antimony was exceeded in both upstream and downstream samples. The chronic aquatic life criteria exceedances for iron and lead were directly attributable to the site. Other aquatic life criteria were exceeded, but not directly attributable to this site. Dunkleburg Creek was very turbid at the time of the investigation due to a recent breach in the tailings impoundment.
- Potential safety hazards identified at the site included an open adit, 12 collapsing structures, and two unstable tailings dams.

**Forest Rose PA# 20-004**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/29/93**

**SOLID MATRIX ANALYSES**

| FIELD ID    | Metals in soils |            | Results per dry weight basis |            |            |            |            |            |            |            |            |            |            | CYANIDE |
|-------------|-----------------|------------|------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|---------|
|             | As (mg/Kg)      | Ba (mg/Kg) | Cd (mg/Kg)                   | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) |         |
| 20-004-SE-1 | 116 JX          | 65.8       | 14.8 J                       | 11.1 J     | 19.9 J     | 125        | 45600 J    | 0.13       | 1370 J     | 34 J       | 1010 J     | 4 U        | 2040 J     | NR      |
| 20-004-SE-2 | 51 JX           | 25.6       | 22 J                         | 3 J        | 3.3 J      | 53.7       | 13700 J    | 0.1        | 1310 J     | 17 J       | 428 J      | 4 U        | 1270 J     | NR      |
| 20-004-SE-3 | 67 JX           | 118        | 13.5 J                       | 9.5 J      | 16.2 J     | 41.7       | 43200 J    | 0.049      | 819 J      | 34 J       | 2820 J     | 6 J        | 2230 J     | NR      |
| 20-004-TP-1 | 336 JX          | 37.6       | 58.2 J                       | 2 J        | 3.8 J      | 444        | 38800 J    | 0.342      | 2090 J     | 15 J       | 6810 J     | 49 J       | 7430 J     | NR      |
| 20-004-TP-2 | 444 JX          | 15         | 143 J                        | 11.2 J     | 4.4 J      | 563        | 109000 J   | 0.377      | 1720 J     | 28 J       | 1820 J     | 28 J       | 16800 J    | NR      |
| 20-004-TP-3 | 330 JX          | 12.2       | 65.1 J                       | 14.3 J     | 3.4 J      | 404        | 113000 J   | 0.052      | 1730 J     | 29 J       | 690 J      | 9 J        | 6590 J     | NR      |
| 20-004-WR-1 | 227             | 13.1       | 40.9                         | 8.6        | 2.9        | 208        | 39200      | 0.648 J    | 1110       | 29         | 4570       | 24 J       | 5660       | NR      |
| 20-004-WR-3 | 801 JX          | 31.2       | 477 J                        | 3.5 J      | 4 J        | 1770       | 75700 J    | 2.93       | 1760 J     | 15 J       | 60400 J    | 470 J      | 51500 J    | NR      |
| 20-004-WR-4 | 350 JX          | 23.1       | 3.2 J                        | 4 J        | 3 J        | 526        | 164000 J   | 0.934      | 165 J      | 16 J       | 242 J      | 7 J        | 2840 J     | NR      |
| BACKGROUND  | 17 JX           | 122        | 0.8 J                        | 10.4 J     | 34.2 J     | 34.6       | 23500 J    | 0.06       | 1040 J     | 36 J       | 38 J       | 5 U        | 106 J      | NR      |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID       | TOTAL    |                  | NEUTRAL POTENT. | SULFUR ACID BASE |                | SULFATE | PYRITIC | ORGANIC | PYRITIC                 |                | SULFUR |
|----------------|----------|------------------|-----------------|------------------|----------------|---------|---------|---------|-------------------------|----------------|--------|
|                | SULFUR % | ACID BASE /1000t |                 | POTENT. /1000t   | POTENT. /1000t |         |         |         | SULFUR ACID BASE /1000t | POTENT. /1000t |        |
| 20-004-TP-1    | 5.86     | 167              | 590             | 423              | 1.94           | 2.48    | 0.94    | 77.5    | 513                     |                |        |
| 20-004-TP-2DUP | 13.8     | 430              | 265             | -165             | <0.01          | 16      | 2.8     | 499     | -234                    |                |        |
| 20-004-TP-2    | 13.7     | 429              | 265             | -163             | <0.01          | 16      | 2.8     | 500     | -235                    |                |        |
| 20-004-TP-3    | 13.3     | 415              | 191             | -224             | <0.01          | 14.6    | 1.94    | 456     | -265                    |                |        |
| 20-004-TP-3DUP | 13.3     | 416              | 186             | -230             | <0.01          | 14.5    | 1.96    | 453     | -267                    |                |        |
| 20-004-WR-1    | 4.76     | 149              | 355             | 206              | 3.31           | 0.09    | 1.36    | 2.81    | 352                     |                |        |
| 20-004-WR-3    | 7.67     | 240              | 64.3            | -175             | 2.71           | 2.89    | 2.07    | 90.3    | -26                     |                |        |
| 20-004-WR-4    | 6.63     | 207              | -5.6            | -213             | 0.06           | 4.95    | 1.62    | 155     | -160                    |                |        |

**WATER MATRIX ANALYSES**

| FIELD ID    | Metals in Water |         | Results in ug/L |         |        |       |       |         |      |        |      |        |      | HARDNESS     |  |
|-------------|-----------------|---------|-----------------|---------|--------|-------|-------|---------|------|--------|------|--------|------|--------------|--|
|             | As              | Ba      | Cd              | Co      | Cr     | Cu    | Fe    | Hg      | Mn   | Ni     | Pb   | Sb     | Zn   | (mg CaCO3/L) |  |
| 20-004-GW-1 | 3 J             | 22.6 JX | 4.1 J           | 9.7 U   | 6.83 U | 4.1 J | 113   | 0.038 U | 35.5 | 12.7 U | 3.86 | 30.7 U | 1700 | 258          |  |
| 20-004-SW-1 | 6.45            | 82.2    | 3.7 J           | 7.63 JX | 17.9   | 31.9  | 16100 | 0.038 U | 453  | 24.2   | 68.7 | 23.8   | 474  | 358          |  |
| 20-004-SW-2 | 1.92            | 13.3    | 2.55 U          | 5.99 UX | 8.83   | 1.43  | 104   | 0.038 U | 7.47 | 9      | 9.13 | 18.3 U | 374  | 199          |  |
| 20-004-SW-3 | 1.41            | 11.3    | 3.3 J           | 5.99 UX | 5.27   | 5.7   | 54.5  | 0.038 U | 6.07 | 8.78 U | 1.73 | 19.4   | 346  | 175          |  |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Wet Chemistry**

| FIELD ID    | Results in mg/l        |          |         |           |         |
|-------------|------------------------|----------|---------|-----------|---------|
|             | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
| 20-004-GW-1 | 309                    | < 5.0    | 78      | 0.1       | NR      |
| 20-004-SW-1 | 448                    | < 5.0    | 160     | 0.07      | NR      |
| 20-004-SW-2 | 250                    | < 5.0    | 77      | < 0.05    | NR      |
| 20-004-SW-3 | 224                    | < 5.0    | 50      | 0.06      | NR      |

**LEGEND**

- |   |  |
|---|--|
| SE1 - Downstream of breached dam on tailings pond 3.  | WR4 - Composite of subsamples WR4A and 4B.             |
| SE2 - At toe of waste rock dump 1.  | BACKGROUND - From the Jackson Park Mine (20-027-SS-1). |
| SE3 - Approx. 400' upstream of end of waste rock dump 2.  | TP2DUP - Duplicate of sample 20-004-TP-2.              |
| TP1 - Composite of subsamples TP1A-A, 1A-B, 1A-C, 1A-D, 1B-A, 1B-B, 1B-C, 1B-D, 1B-E, and 1B-F. | TP3DUP - Duplicate of sample 20-004-TP-3.              |
| TP2 - Composite of subsamples TP2A-A, 2A-B, 2A-C, 2B-A, 2B-B, and 2B-C.                         | GW1 - Discharge from adit #1.                          |
| TP3 - Composite of subsamples TP3A-A, 3A-B, 3B-A, 3B-B, and 3B-C.                               | SW1 - Same as sample SE1.                              |
| WR1 - Composite of subsamples WR1A, 1B, 1C, 2A, and 2B.   | SW2 - Same as sample SE2.                              |
| WR3 - Composite of subsamples WR3A, 3B, and 3C.   | SW3 - Same as sample SE3.                              |



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Wasa  
Legal Description: T 9N R 12W  
Mining District: Dunkleburg  
Latitude: N 46° 29' 53"  
Longitude: W 113° 05' 38"  
Land Status: Private/Public  
Quad: Pikes Peak  
Inspectors: Babits, Lasher/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Granite  
Section(s): SW 1/4, SW 1/4, Sec. 27  
Mine Type: Hardrock/Zn, Au, Ag, Pb, Cu  
Primary Drainage: Douglas Creek  
USGS Code: 17010202  
Secondary Drainage: North Fork of Douglas  
Creek  
Date Investigated: June 29, 1993  
P.A. # 20-023

- There were no tailings on site.
- There were approximately 16,005 cubic yards of uncovered waste rock on site. The following were elevated at least three times background:

|                                 |                           |
|---------------------------------|---------------------------|
| Arsenic: 53 to 108 mg/kg        | Cadmium: 10 to 25.3 mg/kg |
| Copper: 116 to 736 mg/kg        | Iron: 98,500 mg/kg        |
| Mercury: 0.328J to 0.452J mg/kg | Lead: 293 mg/kg           |
| Zinc: 382 to 5,670 mg/kg        |                           |
- There were two discharging adits on site that entered surface water. The samples had pH measurements of 2.57 and 7.50. There was also a pit that held groundwater. This sample had a pH 7.94. The low pH adit exceeded MCLs for cadmium, copper, and antimony. The other adit and pit exceeded MCLs for cadmium and antimony. The chronic aquatic life criteria for iron, nickel, and lead was exceeded in the low pH adit. The chronic and acute aquatic life criteria for copper and zinc was exceeded in the low pH adit. The acute aquatic life criteria was exceeded for cadmium in the neutral pH adit. The chronic and acute aquatic life criteria for zinc was exceeded in the neutral pH adit. The acute and chronic aquatic life criteria for copper zinc was exceeded in the pit.
- The creek ran through waste rock. There were observed releases of cadmium, copper, and zinc in downstream surface water. The acute aquatic life criteria for cadmium was exceeded in downstream surface water. The acute and chronic aquatic life criteria for copper and zinc was exceeded in downstream surface water; however, none of the exceedances were directly attributable to the site.
- There was one open adit and one highwall on site.



**Wasa PA# 20-023**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 06/29/93**

**SOLID MATRIX ANALYSES**

| Metals in soils      |                | Results per dry weight basis        |                               |                                       |                  |                  |                  |                                       |                                       |            |            |            |            |                 |
|----------------------|----------------|-------------------------------------|-------------------------------|---------------------------------------|------------------|------------------|------------------|---------------------------------------|---------------------------------------|------------|------------|------------|------------|-----------------|
| FIELD ID             | As (mg/Kg)     | Ba (mg/Kg)                          | Cd (mg/Kg)                    | Co (mg/Kg)                            | Cr (mg/Kg)       | Cu (mg/Kg)       | Fe (mg/Kg)       | Hg (mg/Kg)                            | Mn (mg/Kg)                            | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 20-023-SE-1          | 166            | 95.9                                | 5.7                           | 67.9                                  | 9.2              | 973              | 21600            | 0.028 J                               | 1960                                  | 35         | 72         | 4 J        | 308        | NR              |
| 20-023-SE-2          | 77             | 67.4                                | 54.4                          | 78.8                                  | 7.9              | 833              | 39100            | 0.058 J                               | 3860                                  | 110        | 94         | 15 J       | 8720       | NR              |
| 20-023-WR-1          | 81             | 113                                 | 19.2                          | 16.3                                  | 8.5              | 588              | 35700            | 0.066 J                               | 1490                                  | 28         | 86         | 11 J       | 4010       | NR              |
| 20-023-WR-2          | 102            | 40.7                                | 0.5 U                         | 1.3                                   | 6.2              | 72               | 20900            | 0.452 J                               | 45.7                                  | 3          | 293        | 14 J       | 67         | NR              |
| 20-023-WR-3          | 53             | 88.9                                | 25.3                          | 29                                    | 8.8              | 736              | 55400            | 0.038 J                               | 1460                                  | 52         | 88         | 12 J       | 5670       | NR              |
| 20-023-WR-4          | 108            | 25.8                                | 0.4 U                         | 4.6                                   | 8.2              | 408              | 98500            | 0.328 J                               | 210                                   | 5          | 44         | 4 J        | 382        | NR              |
| 20-023-WR-5          | 60             | 29.6                                | 10                            | 4.8                                   | 1.7              | 116              | 46300            | 0.386 J                               | 664                                   | 21         | 72         | 4 J        | 1760       | NR              |
| BACKGROUND           | 17 JX          | 122                                 | 0.8 J                         | 10.4 J                                | 34.2 J           | 34.6             | 23500 J          | 0.06                                  | 1040 J                                | 36 J       | 38 J       | 5 U        | 106 J      | NR              |
| Acid/Base Accounting |                |                                     |                               |                                       |                  |                  |                  |                                       |                                       |            |            |            |            |                 |
| FIELD ID             | TOTAL SULFUR % | TOTAL SULFUR ACID BASE $\mu$ /1000t | NEUTRAL. POTENT. $\mu$ /1000t | SULFUR ACID BASE POTENT. $\mu$ /1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE $\mu$ /1000t | SULFUR ACID BASE POTENT. $\mu$ /1000t |            |            |            |            |                 |
| 20-023-WR-1          | 0.03           | 0.94                                | 6.86                          | 5.93                                  | <0.01            | <0.01            | 0.06             | 0                                     | 6.86                                  |            |            |            |            |                 |
| 20-023-WR-2          | 0.63           | 19.7                                | 0.79                          | -19                                   | 0.41             | 0.08             | 0.14             | 2.5                                   | -1.71                                 |            |            |            |            |                 |
| 20-023-WR-3          | 0.06           | 1.87                                | 7.91                          | 6.04                                  | 0.02             | <0.01            | 0.04             | 0                                     | 7.91                                  |            |            |            |            |                 |
| 20-023-WR-4          | 2.25           | 70.3                                | -3.1                          | -73                                   | 2.09             | 0.05             | 0.11             | 1.56                                  | -4.64                                 |            |            |            |            |                 |
| 20-023-WR-5          | 1.59           | 49.7                                | 58.3                          | 8.66                                  | 0.85             | 0.46             | 0.28             | 14.4                                  | 44                                    |            |            |            |            |                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**WATER MATRIX ANALYSES**

| Metals in Water               |                        | Results in ug/L |         |                                     |         |      |       |         |      |      |      |        |      | HARDNESS CALC. Zn (mg CaCO <sub>3</sub> /L) |
|-------------------------------|------------------------|-----------------|---------|-------------------------------------|---------|------|-------|---------|------|------|------|--------|------|---|
| FIELD ID                      | As                     | Ba              | Cd      | Co                                  | Cr      | Cu   | Fe    | Hg      | Mn   | Ni   | Pb   | Sb     | Zn   |   |
| 20-023-GW-1                   | 28.9                   | 11              | 208 J   | 69.6 JX                             | 5 U     | 3330 | 11500 | 0.038 U | 309  | 169  | 1.77 | 18.3 U | 4540 | 32.2  |
| 20-023-GW-2                   | 1.38                   | 6.33            | 19.1 J  | 5.99 UX                             | 5 U     | 10.5 | 303   | 0.038 U | 93.2 | 29.4 | 1.41 | 20     | 3160 | 289   |
| 20-023-GW-3                   | 0.98 U                 | 9.73            | 26 J    | 6.7 JX                              | 6.93    | 19.4 | 125   | 0.038 U | 51.4 | 22.5 | 0.7  | 29.7   | 1770 | 74.5  |
| 20-023-SW-1                   | 6.19                   | 20.1            | 2.57 J  | 5.99 UX                             | 5 U     | 17.4 | 55.7  | 0.038 U | 19.3 | 9.07 | 2.63 | 18.3 U | 89.5 | 17.2  |
| 20-023-SW-2                   | 2.89                   | 8.2             | 51.7 J  | 7.77 JX                             | 6.5     | 95.9 | 112   | 0.044   | 120  | 43.9 | 1.47 | 28.4   | 5250 | 274   |
| Wet Chemistry Results in mg/l |                        |                 |         |                                     |         |      |       |         |      |      |      |        |      |   |
| FIELD ID                      | TOTAL DISSOLVED SOLIDS | CHLORIDE        | SULFATE | NO <sub>3</sub> /NO <sub>2</sub> -N | CYANIDE |      |       |         |      |      |      |        |      |   |
| 20-023-GW-1                   | 260                    | < 5.0           | 179     | 0.06                                | NR      |      |       |         |      |      |      |        |      |   |
| 20-023-GW-2                   | 400                    | < 5.0           | 187     | 0.19                                | NR      |      |       |         |      |      |      |        |      |   |
| 20-023-GW-3                   | 139                    | < 5.0           | 52      | NR                                  | NR      |      |       |         |      |      |      |        |      |   |
| 20-023-SW-1                   | 58                     | < 5.0           | 13      | < 0.05                              | NR      |      |       |         |      |      |      |        |      |   |
| 20-023-SW-2                   | 409                    | < 5.0           | 178     | < 0.05                              | NR      |      |       |         |      |      |      |        |      |   |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**LEGEND**

SE1 - Upgradient in North Fork Douglas Creek.  
 SE2 - Downgradient in North Fork Douglas Creek.  
 WR1 - Composite of subsamples WR1 and 3.  
 WR2 - Sample of subsample WR2.  
 WR3 - Sample of subsample WR4.  
 WR4 - Composite of subsamples WR5 and 6.  
 WR5 - Composite of subsamples WR7A and 7B.  
 BACKGROUND - From Jackson Park Mine (20-027-SS-1).

GW1 - Adit discharge at waste rock dump 2. Discharge goes to N. Fork Douglas Creek.  
 GW2 - Adit discharge at waste rock dump 6.  
 GW3 - From pit.  
 SW1 - Same as subsample SE1.  
 SW2 - Same as subsample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |   |
|--|---|
| Mine/Site Name: <u>Jackson Park</u>              | County: <u>Granite</u>                          |
| Legal Description: <u>T 9 N R 12 W</u>           | Section(s): <u>SW 1/4, SW 1/4, Sec. 13</u>      |
| Mining District: <u>Dunkleburg</u>               | Mine Type: <u>Hardrock/Unknown</u>              |
| Latitude: <u>N 46° 31' 50"</u>                   | Primary Drainage: <u>Dunkleburg Creek</u>       |
| Longitude: <u>W 113° 03' 23"</u>                 | USGS Code: <u>17010202</u>                      |
| Land Status: <u>Private/Public</u>               | Secondary Drainage: <u>Unnamed tributary to</u> |
| Quad: <u>Drummond</u>                            | <u>Dunkleburg Creek</u>                         |
| Inspectors: <u>Babits, Lasher/Pierson</u>        | Date Investigated: <u>July 1, 1993</u>          |
| Organization: <u>Pioneer Technical Services,</u> | P.A. # <u>20-027</u>                            |
| <u>Inc./Thomas, Dean and Hoskins, Inc.</u>       |   |

- No tailings were observed at this site during the investigation.
- There were approximately 2,900 cubic yards of waste rock on site. The majority of the waste rock was covered. The following were elevated at least three times background:

|                                 |                               |
|---------------------------------|-------------------------------|
| Arsenic: 685JX to 1,860JX mg/kg | Cadmium: 17.4J to 18.3J mg/kg |
| Cobalt: 31.5J mg/kg             | Chromium: 125J to 139J mg/kg  |
| Mercury: 0.751 to 1.11 mg/kg    | Manganese: 3,890J mg/kg       |
| Nickel: 122J mg/kg              | Lead: 2,870J to 8,070J mg/kg  |
| Antimony: 61J to 230J mg/kg     | Zinc: 3,080J to 3,250J mg/kg  |
- No discharging adits, filled shafts, seeps, or springs were identified at the site.
- No surface water was flowing on or near the site during the investigation; consequently, no surface water or sediment samples were collected.
- No hazardous openings or structures were identified at the site.

**Jackson Park PA# 20-027**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 06/29/93**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 20-027-WR-1 | 685 JX        | 152           | 18.3 J        | 29.2 J        | 139 J         | 856           | 44500 J       | 0.751         | 2230 J        | 122 J         | 2870 J        | 61 J          | 3080 J        | NR                 |
| 20-027-WR-2 | 1860 JX       | 101           | 17.4 J        | 31.5 J        | 125 J         | 902           | 49900 J       | 1.11          | 3890 J        | 104 J         | 8070 J        | 230 J         | 3250 J        | NR                 |
| BACKGROUND  | 17 JX         | 122           | 0.8 J         | 10.4 J        | 34.2 J        | 34.6          | 23500 J       | 0.06          | 1040 J        | 36 J          | 38 J          | 5 U           | 106 J         | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 20-027-WR-1 | 0.31              | 9.68                                 | 73.9                          | 64.2                                      | 0.3                    | <0.01                  | 0.01                   | 0   | 73.9                                      |
| 20-027-WR-2 | <0.01             | 0                                    | 45.4                          | 45.4                                      | <0.01                  | <0.01                  | 0.01                   | 0   | 45.4                                      |

**LEGEND**

WR1 - Composite of subsamples WR1, 2, and 3.

WR2 - Sample of the subsample WR4.

BACKGROUND - From the Jackson Park Mine (20-027-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Maxville Tailings/  
Londonderry  
Legal Description: T 8 N R 13 W  
Mining District: Maxville  
Latitude: N 46° 28' 27"  
Longitude: W 113° 14' 33"  
Land Status: Private/Public  
Quad: Maxville  
Inspectors: M. Babits, S. Babits/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Granite  
Section(s): SW 1/4, NW 1/4, NW 1/4, Sec. 4  
Mine Type: Hardrock/Ag, Au  
Primary Drainage: Flint Creek  
USGS Code: 17010202  
Secondary Drainage: Boulder Creek  
Date Investigated: September 9, 1993  
P.A. # 20-209

- The volume of tailings associated with this site was estimated to be approximately 10,550 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 1,480 to 4,260 mg/kg      Cadmium: 4.9 to 6.1 mg/kg  
Zinc: 708 to 898 mg/kg
- The volume of waste rock associated with this site was estimated to be approximately 8,400 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 1,340 to 1,790 mg/kg      Antimony: 124J to 135J mg/kg  
Zinc: 151 to 205 mg/kg
- One discharging adit, associated with WR-2, was identified at the site. The pH measurement in the adit discharge was 7.3. MCLs for arsenic and cadmium were exceeded in the adit discharge. Additionally, acute and chronic aquatic life criteria were exceeded for arsenic and zinc, and chronic aquatic life criteria were exceeded for iron and cadmium.
- Flint Creek was flowing directly adjacent to WR-1 and WR-2. An observed release to Flint Creek (sediment) was documented for mercury. Surface water samples were not collected due to extremely high flow and likely excessive dilution.
- A potentially hazardous wooden ore chute was identified at the site.



**Maxville/Londonderry PA# 20-209**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 09/09/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 20-209-SE-1 | 214        | 975 J      | 1.3        | 3.32 J     | 4.87       | 64.4 J     | 8310       | 0.591      | 5280 J     | 3.3 U      | 246        | 13.3 J     | 863        | NR              |
| 20-209-SE-2 | 196        | 1030 J     | 1.5        | 3.19 J     | 3.03       | 61.9 J     | 6950       | 17.9       | 5270 J     | 2.6 U      | 217        | 16.5 J     | 795        | NR              |
| 20-209-TP-1 | 4260       | 150 J      | 4.9        | 1.88 U     | 1.33 U     | 30 J       | 10500      | 0.45       | 245 J      | 2.46 U     | 523        | 151 J      | 898        | NR              |
| 20-209-TP-2 | 1480       | 187 J      | 6.1        | 11.5 J     | 10.1       | 117 J      | 22900      | 0.284      | 697 J      | 11.6       | 190        | 20.7 J     | 708        | NR              |
| 20-209-WR-1 | 1790       | 180 J      | 0.5        | 1.6 U      | 1.13 U     | 14.4 J     | 8000       | 0.41       | 8.47 J     | 2.09 U     | 760        | 124 J      | 151        | NR              |
| 20-209-WR-2 | 1340       | 116 J      | 0.6        | 1.57 U     | 1.55       | 15.3 J     | 7240       | 0.826      | 9.4 J      | 2.1        | 1120       | 135 J      | 205        | NR              |
| BACKGROUND  | 76.3       | 329        | 1.6        | 6.18       | 6.06       | 116        | 11700      | 1.33 J     | 1530 J     | 6.77       | 85.8       | 33.3       | 47.4       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID       | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|----------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 20-209-TP-1    | 0.42           | 13.1                           | 2.19                    | -11                              | 0.31             | 0.09             | 0.02             | 2.81                             | -0.62                            |
| 20-209-TP-2    | 0.69           | 21.6                           | 36.5                    | 14.9                             | 0.69             | <0.01            | 0.02             | 0                                | 36.5                             |
| 20-209-WR-1    | 0.08           | 2.5                            | 0.28                    | -2.2                             | 0.07             | <0.01            | 0.01             | 0                                | 0.28                             |
| 20-209-WR1-DUP | 0.07           | 2.19                           | 0.15                    | -2                               | 0.05             | 0.01             | 0.01             | 0.31                             | -0.16                            |
| 20-209-WR-2    | 0.1            | 3.12                           | 0.74                    | -2.4                             | 0.08             | 0.01             | 0.01             | 0.31                             | 0.43                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As      | Ba   | Cd   | Co    | Cr     | Cu | Fe    | Hg     | Mn   | Ni   | Pb   | Sb       | Zn (mg CaCO3/L) | HARDNESS CALC. (mg CaCO3/L) |
|-------------|---------|------|------|-------|--------|----|-------|--------|------|------|------|----------|-----------------|-----------------------------|
| 20-209-SW-1 | 2350 JX | 28.1 | 5.57 | 9.7 U | 6.83 U | 2  | 11600 | 0.12 U | 1090 | 25.9 | 2.15 | 30.7 UJX | 2630            | 251                         |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 20-209-SW-1 | 392                    | 3.9      | 137     | 0.11      | NR      |

**LEGEND**

SE1 - 150 feet upgradient from waste rock dump 2.  
SE2 - 200 feet downgradient from waste rock dump 1.  
TP1 - Composite of subsamples TP1A-A, 1A-B, 2A-A, and 2A-B.  
TP2 - Composite of subsamples TP1A-C and 1B-B.  
WR1 - Composite of subsamples WR1, 2A, 2B, and 3.  
WR2 - Sample of the WR3 subsample.  
WR1-DUP - Duplicate of 20-209-WR-1.

BACKGROUND - From the Combination Mine.  
(20-009-SS-1)  
SW1 - Adit discharge at waste rock dump 2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Banner Tailings</u>                | County: <u>Granite</u>                            |
| Legal Description: <u>T 4N R 16W</u>                  | Section(s): <u>SE 1/4, SW 1/4, Sec. 36</u>        |
| Mining District: <u>Moose Lake</u>                    | Mine Type: <u>Hardrock/Au, Ag</u>                 |
| Latitude: <u>N 46° 03' 04"</u>                        | Primary Drainage: <u>Middle Fork Rock Creek</u>   |
| Longitude: <u>W 113° 32' 04"</u>                      | USGS Code: <u>17010202</u>                        |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Middle Fork Rock Creek</u> |
| Quad: <u>Moose Lake</u>                               | Date Investigated: <u>June 21, 1993</u>           |
| Inspectors: <u>Tuesday, Belanger, Lasher</u>          | P.A. # <u>20-175</u>                              |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- The volume of tailings associated with this site was estimated to be 2,500 cubic yards. The following elements were elevated at least three times background:

|                       |                      |
|-----------------------|----------------------|
| Arsenic: 155J mg/kg   | Copper: 65.1 mg/kg   |
| Mercury: 1.46JX mg/kg | Lead: 898 mg/kg      |
| Antimony: 220J mg/kg  | Cyanide: 0.265 mg/kg |
- Tailings were recently dozed and were mostly enclosed in a basin with no apparent outlet; however, there was no impoundment structure and the tails were unvegetated.
- The volume of waste rock associated with this site was estimated to be 15,000 cubic yards. The following elements were elevated at least three times background:

|                     |                      |
|---------------------|----------------------|
| Arsenic: 140J mg/kg | Copper: 114 mg/kg    |
| Lead: 424 mg/kg     | Antimony: 125J mg/kg |
- The waste rock dumps were being undercut by and actively eroded into the Middle Fork Rock Creek. No observed releases or exceedances of drinking water standards or aquatic life criteria were documented during this investigation.
- No adit discharges, seeps or springs were observed. No hazardous structures, mine openings, or highwalls were present.

**Banner PA# 20-175**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 06/21/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 20-175-SE-1 | 11 J          | 81.8          | 0.6 U         | 1.5 U         | 5.8           | 8.2           | 4660          | 0.055 JX      | 88            | 4             | 6 U           | 4 UJ          | 22            | NR                 |
| 20-175-SE-2 | 7 J           | 102           | 0.7 U         | 2.3           | 6.8           | 11.7          | 5580          | 0.052 JX      | 121           | 6             | 14            | 5 UJ          | 32            | NR                 |
| 20-175-TP-1 | 155 J         | 38.1          | 1.1           | 1.3 U         | 1 U           | 65.1          | 3990          | 1.46 JX       | 7.8           | 2 U           | 898           | 220 J         | 36            | 0.265              |
| 20-175-WR-1 | 140 J         | 84.6          | 0.5           | 1.2           | 0.9 U         | 114           | 17800         | 1 JX          | 223           | 4             | 424           | 125 J         | 35            | NR                 |
| BACKGROUND  | 11 J          | 267           | 1.7           | 11            | 8.7           | 7.8           | 12800         | 0.08 JX       | 250           | 9             | 15            | 5 UJ          | 62            | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL.<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|--------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 20-175-TP-1 | 0.04              | 1.25                                 | 0.93                           | -0.3                                      | 0.03                   | <0.01                  | 0.01                   | 0   | 0.93                                      |
| 20-175-WR-1 | 0.23              | 7.19                                 | 1.9                            | -5.3                                      | 0.22                   | <0.01                  | 0.02                   | 0   | 1.9                                       |

**LEGEND**

SE1 - Upstream of dumps.  
SE2 - Downstream of dumps.  
TP1 - Composite of subsamples TP1A through 1D.  
WR1 - Composite of subsamples WR1A through 1E.  
BACKGROUND - From the Montana Prince Mine (41-004-SS-1)

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Old Dominion Mine</u>              | County: <u>Granite</u>                            |
| Legal Description: <u>T 4N R 16W</u>                  | Section(s): <u>SE 1/4, SE 1/4, Sec. 36</u>        |
| Mining District: <u>Moose Lake</u>                    | Mine Type: <u>Hardrock/Au</u>                     |
| Latitude: <u>N 46° 02' 55"</u>                        | Primary Drainage: <u>Middle Fork Rock Creek</u>   |
| Longitude: <u>W 113° 31' 30"</u>                      | USGS Code: <u>17010202</u>                        |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Middle Fork Rock Creek</u> |
| Quad: <u>Moose Lake</u>                               | Date Investigated: <u>June 21, 1993</u>           |
| Inspectors: <u>Tuesday, Belanger, Lasher</u>          | P.A. # <u>20-180</u>                              |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- The volume of tailings associated with this site was estimated to be 5,600 cubic yards. The following elements were elevated at least three times background:  
Copper: 28.5 mg/kg                      Mercury: 0.445JX mg/kg  
Lead: 103 mg/kg                      Cyanide: 0.282 mg/kg
- Tailings were within an enclosed basin with no apparent outlet or impoundment structure and the tailings were mostly (75%) revegetated
- The volume of waste rock associated with this site was estimated to be 6,700 cubic yards. The following element was elevated at least three times background:  
Lead: 68 mg/kg
- One observed release of lead was documented in downgradient well. No exceedances of drinking water standards or aquatic life criteria were documented during this investigation.
- No adit discharges, seeps or springs were observed. Two hazardous structures were on site: the mill building and an old generator building. No mine openings, or highwalls were present.



**Old Dominion PA# 20-180**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 06/21/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 20-180-TP-1 | 13 J       | 225        | 0.6 U      | 1.4 U      | 4          | 28.5       | 6080       | 0.445 JX   | 29         | 3          | 103        | 4 UJ       | 9          | 0.282           |
| 20-180-WR-1 | 6 J        | 22.4       | 0.5 U      | 1.2 U      | 1 U        | 6.7        | 2280       | 0.195 JX   | 8.2        | 3          | 68         | 4 UJ       | 8          | NR              |
| BACKGROUND  | 11 J       | 267        | 1.7        | 11         | 8.7        | 7.8        | 12800      | 0.08 JX    | 250        | 9          | 15         | 5 UJ       | 62         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 20-180-TP-1 | 0.01           | 0.31                           | 1.06                     | 0.75                             | 0.01             | <0.01            | <0.01            | 0                                | 1.06                             |
| 20-180-WR-1 | 0.01           | 0.31                           | 2.58                     | 2.26                             | <0.01            | 0.01             | <0.01            | 0.31                             | 2.26                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba  | Cd     | Co    | Cr     | Cu   | Fe   | Hg      | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|-----|--------|-------|--------|------|------|---------|--------|--------|--------|--------|-----------------|----------------|
| 20-180-GW-1 | 0.98 U | 116 | 2.57 U | 9.7 U | 6.83 U | 55.5 | 15.3 | 0.038 U | 4.08 U | 12.7 U | 0.38 U | 30.7 U | 12.8            | 101            |
| 20-180-GW-2 | 0.98 U | 313 | 2.57 U | 9.7 U | 6.83 U | 8.93 | 102  | 0.038 U | 4.3    | 12.7 U | 0.38 U | 30.7 U | 8.43            | 93.6           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 20-180-GW-1 | 127                    | < 5.0    | 5       | 0.08      | NR      |
| 20-180-GW-2 | 139                    | < 5.0    | 6       | 0.09      | NR      |

**LEGEND**

TP1 - Composite of subsamples TP1A-A, 1B-A, 1B-B, 1C-A, and 1D-A.  
WR1 - Composite of subsamples WR1A, 1B, 2A, 2B, and 2C.  
BACKGROUND - From the Montana Prince Mine (41-004-SS-1).

GW1 - Petersen residence (upgradient) West of site.  
GW2 - Floyd's residence (downgradient) North of site.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Bi-Metallic/Old Red</u>            | County: <u>Granite</u>                     |
| Legal Description: <u>T 7N R 13W</u>                  | Section(s): <u>NE 1/4, SW 1/4, Sec. 33</u> |
| Mining District: <u>Philipsburg</u>                   | Mine Type: <u>Hardrock/Ag, Au, Pb</u>      |
| Latitude: <u>N 46° 18' 44"</u>                        | Primary Drainage: <u>Flint Creek</u>       |
| Longitude: <u>W 113° 16' 16"</u>                      | USGS Code: <u>17010202</u>                 |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Douglas Creek</u>   |
| Quad: <u>Fred Burr Lake/Philipsburg</u>               | Date Investigated: <u>June 22, 1993</u>    |
| Inspectors: <u>Tuesday, Belanger, Lasher</u>          | P.A. # <u>20-002</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- The mill tailings associated with this site were slurried in flumes down a dry tributary to Douglas Creek, and were probably the source of the Douglas Creek Tailings. The total volume of tailings was roughly estimated at 40 cubic yards, but may be significantly more. The tailings in the drainage were 90% revegetated, while those at the mill site were not. The following elements were elevated at least three times background:

|                      |                    |
|----------------------|--------------------|
| Arsenic: 3,270 mg/kg | Cadmium: 3.2 mg/kg |
| Copper: 126 mg/kg    | Mercury: 1.5 mg/kg |
| Manganese: 3,760     | Lead: 667J mg/kg   |
| Antimony: 112J mg/kg | Zinc: 469 mg/kg    |
- The volume of waste rock associated with this site was estimated to be 62,000 cubic yards. The following elements were elevated at least three times background:

|                                |                            |
|--------------------------------|----------------------------|
| Arsenic: 2,860 to 8,230J mg/kg | Cadmium: 1.7 mg/kg         |
| Copper: 72.5J mg/kg            | Mercury: 2.02 mg/kg        |
| Lead: 667J mg/kg               | Antimony: 78J to 79J mg/kg |
| Zinc: 387 to 568 mg/kg         |                            |
- The Bimetallic site was intimately associated with the Granite Mine site to the east. No real boundary exists separating the two sites. For the investigation, the access road was the dividing line between the two.
- No observed releases, exceedances of drinking water standards or aquatic life criteria were documented at this site.
- No discharging adits, springs or seeps were observed.
- No hazardous structures or openings existed at the site.

**Bimetallic/Old Red PA# 20-002**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/22/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 20-002-TP-1 | 3270       | 201        | 3.2        | 2.4        | 2.3        | 126 J      | 18100      | 1.5        | 3760       | 15 J       | 667 J      | 112 J      | 469        | 0.292 U         |
| 20-002-WR-1 | 8230 J     | 108        | 0.6 U      | 1.8        | 1.1        | 32.4       | 26900      | 0.801 JX   | 179        | 2 U        | 386        | 79 J       | 387        | NR              |
| 20-002-WR-2 | 2860       | 114        | 1.7        | 3.9        | 2.8        | 72.5 J     | 20200      | 2.02       | 2200       | 12 J       | 413 J      | 78 J       | 568        | NR              |
| BACKGROUND  | 25 J       | 286        | 0.5 U      | 9.8        | 4.6        | 9          | 13900      | 0.161 JX   | 1230       | 11         | 9          | 4 UJ       | 41         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 20-002-TP-1 | 0.19           | 5.94                           | 5.62                     | -0.3                             | 0.12             | <0.01            | 0.07             | 0                                | 5.62                             |
| 20-002-WR-1 | 0.74           | 23.1                           | -2.1                     | -25                              | 0.59             | 0.01             | 0.14             | 0.31                             | -2.36                            |
| 20-002-WR-2 | 1.17           | 36.6                           | 5.19                     | -31                              | 0.32             | 0.62             | 0.23             | 19.4                             | -14.2                            |

**LEGEND**

TP1 - Composite of subsamples TP1, 2, and 3.  
WR1 - Composite of subsamples WR1A, 1B, and 1C.  
WR2 - Composite of subsamples WR2A and 2B.  
BACKGROUND - From the Granite Mountain Mine (20-110-SS1)

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Douglas Creek</u>                  | County: <u>Granite</u>                     |
| Legal Description: T <u>7N</u> R <u>13W</u>           | Section(s): <u>SE 1/4, SE 1/4, Sec. 31</u> |
| Mining District: <u>Philipsburg</u>                   | Mine Type: <u>Tailings/Au, Ag, Pb</u>      |
| Latitude: <u>N 46° 18' 38"</u>                        | Primary Drainage: <u>Douglas Creek</u>     |
| Longitude: <u>W 113° 15' 50"</u>                      | USGS Code: <u>17010202</u>                 |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>None</u>            |
| Quad: <u>Philipsburg</u>                              | Date Investigated: <u>June 23, 1993</u>    |
| Inspectors: <u>Bullock, Flammang, Lasher</u>          | P.A. # <u>20-003</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- The volume of tailings associated with this site was estimated to be approximately 295,000 cubic yards. The following elements were elevated at least three times background:

|                               |                                  |
|-------------------------------|----------------------------------|
| Arsenic: 1,520 to 2,950 mg/kg | Manganese: 4,270 to 13,700 mg/kg |
| Cadmium: 2.4 to 5.7 mg/kg     | Nickel: 44J to 56J mg/kg         |
| Copper: 63.1J to 181J mg/kg   | Lead: 336J to 1,430J mg/kg       |
| Mercury: 1.06 to 16.4 mg/kg   | Antimony: 115J to 224J mg/kg     |
| Zinc: 464 to 2,030 mg/kg      |                                  |
- There was no waste rock observed at this site during the investigation.
- No adit discharges, filled shafts, springs, or seeps were observed at the site during the investigation.
- The site was situated directly in the intermittent Douglas Creek drainage; surface water was flowing through and under the tailings piles at the time of this investigation. Three surface water samples were collected from Douglas Creek (upstream, center of site, and downstream). Observed releases to Douglas Creek were documented for arsenic, manganese, lead, and zinc. The MCL for arsenic was exceeded and was directly attributable to the site. The acute and chronic aquatic life criteria for copper and zinc, and the chronic aquatic life criteria for mercury and lead were exceeded in all of the samples, and therefore not directly attributable to the site. Observed releases for arsenic, manganese, and nickel were also documented in the stream sediment samples. The upstream sediment mercury concentration was significantly elevated at 22.5 mg/kg.
- One potentially hazardous adit opening was identified approximately 0.5 miles above this site. Both tailings impoundments had unstable slopes down to the stream, and both tailings dams had been breached.



**Douglas Creek PA# 20-003**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/23/93**

| SOLID MATRIX ANALYSES |                |                                |                          |                                  |                  |                  |                  |                                  |                                  |  |            |            |            |                 |
|-----------------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|--|------------|------------|------------|-----------------|
| Metals in soils       |                | Results per dry weight basis   |                          |                                  |                  |                  |                  |                                  |                                  |  |            |            |            |                 |
| FIELD ID              | As (mg/Kg)     | Ba (mg/Kg)                     | Cd (mg/Kg)               | Co (mg/Kg)                       | Cr (mg/Kg)       | Cu (mg/Kg)       | Fe (mg/Kg)       | Hg (mg/Kg)                       | Mn (mg/Kg)                       | Ni (mg/Kg)                                     | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 20-003-SE-1           | 900            | 136                            | 3.3                      | 5.5                              | 2.8              | 95.1 J           | 12300            | 22.5                             | 3030                             | 14 J   | 390 J      | 46 J       | 763        | NR              |
| 20-003-SE-2           | 1260           | 128                            | 2.3                      | 5.1                              | 4.1              | 75.1 J           | 13400            | 3.84                             | 3390                             | 13 J   | 403 J      | 81 J       | 535        | NR              |
| 20-003-SE-3           | 2140           | 265                            | 4.7                      | 7                                | 6.4              | 129 J            | 18500            | 3.78                             | 10600                            | 44 J   | 535 J      | 135 J      | 1030       | NR              |
| 20-003-TP-1A          | 3710           | 491                            | 5.7                      | 2.4                              | 4.5              | 181 J            | 13700            | 16.4                             | 13700                            | 56 J   | 1430 J     | 224 J      | 2030       | NR              |
| 20-003-TP-1B          | 2710           | 274                            | 3.8                      | 1.4 U                            | 2.7              | 75.1 J           | 8380             | 3.17                             | 11500                            | 44 J   | 556 J      | 186 J      | 985        | NR              |
| 20-003-TP-2A          | 2140           | 146                            | 2.7                      | 3.7                              | 3.5              | 118 J            | 14700            | 1.06                             | 4270                             | 18 J   | 602 J      | 125 J      | 464        | NR              |
| 20-003-TP-2BA         | 1520           | 185                            | 2.4                      | 3.7                              | 3.5              | 63.1 J           | 13700            | 1.52                             | 4270                             | 16 J   | 336 J      | 115 J      | 496        | NR              |
| 20-003-TP-2BB         | 2950           | 309                            | 4                        | 2.4                              | 3.8              | 148 J            | 20400            | 1.44                             | 7050                             | 27 J   | 974 J      | 156 J      | 817        | NR              |
| BACKGROUND            | 25 J           | 286                            | 0.5 U                    | 9.8                              | 4.6              | 9                | 13900            | 0.161 JX                         | 1230                             | 11   | 9          | 4 UJ       | 41         | NR              |
| Acid/Base Accounting  |                |                                |                          |                                  |                  |                  |                  |                                  |                                  |  |            |            |            |                 |
| FIELD ID              | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t | Cation Exchange Capacity milliequivalents/100g |            |            |            |                 |
| 20-003-TP1A           | 0.29           | 9.06                           | 37.5                     | 28.4                             | 0.05             | 0.16             | 0.08             | 5                                | 32.5                             | 4.05   |            |            |            |                 |
| 20-003-TP1B           | 0.29           | 9.06                           | 26.5                     | 17.4                             | 0.13             | 0.11             | 0.05             | 3.44                             | 23.1                             | 1.29   |            |            |            |                 |
| 20-003-TP2A           | 0.18           | 5.62                           | 6.24                     | 0.62                             | 0.12             | 0.01             | 0.05             | 0.31                             | 5.93                             | 3.38   |            |            |            |                 |
| 20-003-TP2B-A         | 0.11           | 3.44                           | 14.4                     | 11                               | 0.02             | 0.03             | 0.06             | 0.94                             | 13.5                             | 3.13   |            |            |            |                 |
| 20-003-TP2B-B         | 0.38           | 11.9                           | 15.6                     | 3.75                             | 0.26             | 0.06             | 0.06             | 1.87                             | 13.8                             | 5.22   |            |            |            |                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

| WATER MATRIX ANALYSES         |                        |                 |         |           |         |      |      |      |      |        |      |        |                 |                |
|-------------------------------|------------------------|-----------------|---------|-----------|---------|------|------|------|------|--------|------|--------|-----------------|----------------|
| Metals in Water               |                        | Results in ug/L |         |           |         |      |      |      |      |        |      |        |                 |                |
| FIELD ID                      | As                     | Ba              | Cd      | Co        | Cr      | Cu   | Fe   | Hg   | Mn   | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
| 20-003-SW-1                   | 24.3                   | 28.5            | 2.57 U  | 9.7 U     | 6.83 U  | 5.43 | 63.7 | 0.11 | 16.1 | 12.7 U | 1.33 | 30.7 U | 51.9            | 24.3           |
| 20-003-SW-2                   | 72.2                   | 28.2            | 2.57 U  | 9.7 U     | 6.83 U  | 5.9  | 270  | 0.25 | 557  | 12.7 U | 4.1  | 30.7 U | 115             | 29.1           |
| 20-003-SW-3                   | 87.4                   | 25.3            | 2.57 U  | 9.7 U     | 6.83 U  | 6.37 | 316  | 0.17 | 807  | 12.7 U | 5.55 | 30.7 U | 249             | 33.1           |
| Wet Chemistry Results in mg/l |                        |                 |         |           |         |      |      |      |      |        |      |        |                 |                |
| FIELD ID                      | TOTAL DISSOLVED SOLIDS | CHLORIDE        | SULFATE | NO3/NO2-N | CYANIDE |      |      |      |      |        |      |        |                 |                |
| 20-003-SW-1                   | 81                     | < 5.0           | 10      | < 0.05    | NR      |      |      |      |      |        |      |        |                 |                |
| 20-003-SW-2                   | 95                     | < 5.0           | 15      | < 0.05    | NR      |      |      |      |      |        |      |        |                 |                |
| 20-003-SW-3                   | 98                     | < 5.0           | 20      | 0.06      | NR      |      |      |      |      |        |      |        |                 |                |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**LEGEND**

- SE1 - Located approx. 100' upstream from the east end of tailings pond 2.
- SE2 - Approx. 70' downstream of tailings pond 2, below confluence of two stream channels.
- SE3 - Approx. 100' below tailings pond 1.
- TP1A - Composite of subsamples TP1A-A through 1A-E.
- TP1B - Composite of subsamples TP1B-A through 1B-D.
- TP2A - Composite of subsamples 2A-A through 2A-F.
- TP2B-A - Composite of subsamples TP2B-A and 2B-B.
- TP2B-B - Composite of subsamples TP2B-C and 2B-D.
- BACKGROUND - From the Granite Mountain Mine (20-110-SS-1).
- SW1 - Same as sample SE1.
- SW2 - Same as sample SE2.
- SW3 - Same as sample SE3.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Algonquin</u>                      | County: <u>Granite</u>                        |
| Legal Description: <u>T 7N R 13W</u>                  | Section(s): <u>SE 1/4, SE 1/4, Sec. 30</u>    |
| Mining District: <u>Philipsburg</u>                   | Mine Type: <u>Hardrock/Ag, Au, Pb, Zn, Mn</u> |
| Latitude: <u>N 46° 19' 40"</u>                        | Primary Drainage: <u>Douglas Creek</u>        |
| Longitude: <u>W 113° 15' 57"</u>                      | USGS Code: <u>17010202</u>                    |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Frost Creek</u>        |
| Quad: <u>Philipsburg</u>                              | Date Investigated: <u>June 23, 1993</u>       |
| Inspectors: <u>Tuesday, Belanger, Clark</u>           | P.A. # <u>20-005</u>                          |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be 52,500 cubic yards. The following elements were elevated at least three times background:

|                                 |                             |
|---------------------------------|-----------------------------|
| Arsenic : 99 to 1,420 mg/kg     | Cadmium: 10 to 35.4 mg/kg   |
| Chromium: 21.9 mg/kg            | Copper: 69.1 to 1,570 mg/kg |
| Iron: 48,800 mg/kg              | Mercury: 1.02 mg/kg         |
| Manganese: 4,590 to 9,850 mg/kg | Nickel: 51 mg/kg            |
| Lead: 747 to 1,270 mg/kg        | Antimony: 17 to 42 mg/kg    |
| Zinc: 4,890 to 15,400 mg/kg     |                             |
- The waste rock dumps were mostly unvegetated and WR-1 had been undercut, which resulted in unstable highwalls on the dump.
- Frost Creek flowed through the site. No observed releases or exceedances of drinking water standards were documented during this investigation. Aquatic life criteria for zinc (both acute and chronic) were exceeded both up- and downstream in Frost Creek. No adit discharges, seeps or springs were observed.
- Two hazardous structures were onsite: one older mine office building and an old shed. One mine opening was onsite: a shaft fenced by Department of State Lands, but was still open and hazardous (headframe has collapsed into shaft).
- Observed probable asbestos insulation on the boiler in the mine building.

**Algonquin PA# 20-005**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 06/23/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 20-005-SE-1 | 14         | 80.4       | 0.5 U      | 10.6       | 6.1        | 6.7 J      | 16500      | 0.025      | 591        | 2 J        | 98 J       | 4 U        | 238        | NR              |
| 20-005-SE-2 | 13         | 119        | 1.2        | 8.3        | 3.2        | 9.8 J      | 10300      | 0.044      | 1700       | 6 J        | 185 J      | 4 U        | 600        | NR              |
| 20-005-WR-1 | 99         | 65.6       | 10         | 3.4        | 6.2        | 69.1 J     | 21000      | 1.02       | 1540       | 13 J       | 747 J      | 17 J       | 4890       | NR              |
| 20-005-WR-2 | 1420       | 36.7       | 34.8       | 7.3        | 21.9       | 1570 J     | 48800      | 1.02       | 4590       | 28 J       | 585 J      | 35 J       | 15300      | NR              |
| 20-005-WR-3 | 776        | 51.3       | 35.4       | 16.9       | 8.4        | 690 J      | 28700      | 0.354      | 9850       | 51 J       | 1270 J     | 42 J       | 15400      | NR              |
| BACKGROUND  | 25 J       | 286        | 0.5 U      | 9.8        | 4.6        | 9          | 13900      | 0.161 JX   | 1230       | 11         | 9          | 4 UJ       | 41         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 20-005-WR-1 | 1.28           | 40                             | 145                     | 105                              | 0.4              | 0.24             | 0.64             | 7.5                              | 137                              |
| 20-005-WR-2 | 2.17           | 67.8                           | 117                     | 48.7                             | 1.05             | 0.41             | 0.71             | 12.8                             | 104                              |
| 20-005-WR-3 | 1.53           | 47.8                           | 408                     | 360                              | <0.01            | 0.61             | 1.56             | 19.1                             | 389                              |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co    | Cr     | Cu     | Fe  | Hg      | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|------|--------|-------|--------|--------|-----|---------|------|--------|--------|--------|-----------------|----------------|
| 20-005-SW-1 | 3.19 | 23.1 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 104 | 0.038 U | 37.7 | 12.7 U | 0.38 U | 30.7 U | 56.4            | 21.3           |
| 20-005-SW-2 | 3.53 | 24.4 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 160 | 0.038 U | 44.8 | 12.7 U | 0.38 U | 30.7 U | 63.1            | 21.5           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 20-005-SW-1 | 94                     | < 5.0    | 8       | 0.06      | NR      |
| 20-005-SW-2 | 75                     | < 5.0    | 8       | 0.05      | NR      |

**LEGEND**

SE1 - Upstream of site in Frost Creek.  
SE2 - Downstream from site, 100' in Frost Creek.  
WR1 - Composite of subsamples WR1A through 1C and WR2A through 2C.  
WR2 - Composite of subsamples WR3A and 3B.  
WR3 - Composite of subsamples WR4A through 4C.  
BACKGROUND - From the Granite Mountain Mine (20-110-SS-1).

SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Rumsey</u>                         | County: <u>Granite</u>                     |
| Legal Description: T <u>6N</u> R <u>13W</u>           | Section(s): <u>NE 1/4, NE 1/4, Sec. 8</u>  |
| Mining District: <u>Philipsburg</u>                   | Mine Type: <u>Hardrock/Au, Ag</u>          |
| Latitude: <u>N 46° 17' 32"</u>                        | Primary Drainage: <u>Flint Creek</u>       |
| Longitude: <u>W 113° 14' 49"</u>                      | USGS Code: <u>17010202</u>                 |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Fred Burr Creek</u> |
| Quad: <u>Philipsburg/Fred Burr Lake</u>               | Date Investigated: <u>June 24, 1993</u>    |
| Inspectors: <u>Tuesday, Belanger, Clark</u>           | P.A. # <u>20-018</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- The mill tailings associated with this site were not impounded but were in the floodplain of Fred Burr Creek and extended at least one mile downstream from the site. The volume of these tailings were estimated at 2,800 cubic yards and were 90% revegetated (naturally). The following elements were elevated at least three times background:

|                     |                    |
|---------------------|--------------------|
| Arsenic : 520 mg/kg | Cadmium: 9.3 mg/kg |
| Copper: 63.8 mg/kg  | Mercury: 4.7 mg/kg |
| Lead: 195 mg/kg     | Zinc: 1,130 mg/kg  |
- The volume of waste rock associated with this site was estimated to be 22,000 cubic yards. None of the elements analyzed were elevated above three times background.
- An observed release to surface water (Fred Burr Creek) was documented in sediments for arsenic, copper, mercury, lead, and zinc. No exceedances of drinking water standards or aquatic life criteria were documented in Fred Burr Creek.
- One discharging adit had a significant flow (13 gpm). The adit water (SW-2) had a pH of 6.70, an specific conductance of 207 us/cm, and did not exceed drinking water standards; aquatic life criteria for mercury (chronic) was exceeded in the adit discharge.
- The old stone mill foundation could be hazardous. The large (10 by 12 feet) adit was a hazardous mine opening.



**Rumsey PA# 20-018**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 06/24/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 20-018-SE-1 | 4          | 25.3 J     | 0.5 U      | 3          | 2          | 2.6        | 8100       | 0.068 J    | 93.6 J     | 3 J        | 5 U        | 4 U        | 11         | NR              |
| 20-018-SE-3 | 196        | 64 J       | 0.8        | 4.1        | 1.2        | 20.3       | 12100      | 5.56 J     | 758 J      | 4 J        | 67         | 5          | 277        | NR              |
| 20-018-TP-1 | 520        | 233 J      | 9.3        | 10.6       | 8.4        | 63.8       | 31200      | 4.7 J      | 1550 J     | 13 J       | 195        | 6          | 1130       | 0.304           |
| 20-018-WR-1 | 5          | 201 J      | 0.5 U      | 15.7       | 6.8        | 15.8       | 26300      | 0.423 J    | 542 J      | 8 J        | 4 U        | 4 U        | 52         | NR              |
| BACKGROUND  | 25 J       | 286        | 0.5 U      | 9.8        | 4.6        | 9          | 13900      | 0.161 JX   | 1230       | 11         | 9          | 4 UJ       | 41         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 20-018-TP-1 | 0.01           | 0.31                           | 4.27                    | 3.95                             | 0.01             | <0.01            | 0.01             | 0                                | 4.27                             |
| 20-018-WR-1 | <0.01          | 0                              | 46.5                    | 46.5                             | <0.01            | <0.01            | 0.02             | 0                                | 46.5                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu     | Fe   | Hg   | Mn | Ni     | Pb     | Sb     | HARDNESS CALC. Zn (mg CaCO3/L) |
|-------------|--------|------|--------|-------|--------|--------|------|------|----|--------|--------|--------|--------------------------------|
| 20-018-SW-2 | 0.98 U | 3.63 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 73.9 | 0.11 | 8  | 12.7 U | 0.38 U | 30.7 U | 7.57 U 80.2                    |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID.   | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 20-018-SW-2 | 122                    | < 5.0    | 12      | 0.09      | NR      |

**LEGEND**

SE1 - Upstream in Fred Burr Creek - 120 feet.  
SE3 - Downstream in Fred Burr Creek - 1/2 mile.  
TP1 - Composite of subsamples TP1B-1, 1A-1, and 1C-1.  
WR1 - Composite of subsamples WR1A, 1B, 1C, 2A, and 3A.  
BACKGROUND - From the Granite Mountain Mine (20-110-SS-1).

SW2 - Adit discharge.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Scratch All</u>                    | County: <u>Granite</u>                     |
| Legal Description: T <u>7N</u> R <u>13W</u>           | Section(s): <u>NE 1/4, SE 1/4, Sec. 30</u> |
| Mining District: <u>Philipsburg</u>                   | Mine Type: <u>Hardrock/Mn, Pb, Zn, Ag</u>  |
| Latitude: <u>N 46° 19' 53"</u>                        | Primary Drainage: <u>Camp Creek</u>        |
| Longitude: <u>W 113° 15' 59"</u>                      | USGS Code: <u>17010202</u>                 |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>None</u>            |
| Quad: <u>Philipsburg</u>                              | Date Investigated: <u>June 22, 1993</u>    |
| Inspectors: <u>Bullock, Flammang, Clark</u>           | P.A. # <u>20-019</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no mill tailings observed at this site during this investigation.
- The volume of waste rock associated with this site was estimated to be approximately 543,000 cubic yards. The following elements were elevated at least three times background:

|                                   |                              |
|-----------------------------------|------------------------------|
| Arsenic: 264 to 377 mg/kg         | Nickel: 62J to 95J mg/kg     |
| Cadmium: 9.5 to 33.3 mg/kg        | Lead: 1,090J to 2,950J mg/kg |
| Copper: 166J to 386J mg/kg        | Antimony: 28J mg/kg          |
| Mercury: 0.654 to 1.14 mg/kg      | Zinc: 4,480 to 17,700 mg/kg  |
| Manganese: 11,700 to 18,700 mg/kg |                              |
- No adit discharges, filled shafts, seeps, or springs were observed at the site during the investigation, and no other surface water was located on or near the site; consequently, no groundwater or surface water samples were collected.
- Four potentially hazardous mine openings were identified at the site including two fenced shafts, one partially blocked adit, and one open adit. A 15 feet tall highwall associated with the pit was also potentially hazardous. Six structures were identified that presented potential safety hazards; and several drums/tanks were located on-site that may contain hazardous materials. Potential asbestos containing materials were also identified on-site.

**Scratch All PA# 20-019**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/22/93**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 20-019-WR-1 | 377           | 80.4          | 33.3          | 4             | 9.3           | 386 J         | 14200         | 1.14          | 11700         | 62 J          | 2950 J        | 28 J          | 17700         | NR                 |
| 20-019-WR-2 | 264           | 75.5          | 9.5           | 6.5           | 11.1          | 166 J         | 18000         | 0.654         | 18700         | 95 J          | 1090 J        | 7 J           | 4480          | NR                 |
| BACKGROUND  | 25 J          | 286           | 0.5 U         | 9.8           | 4.6           | 9             | 13900         | 0.161 JX      | 1230          | 11            | 9             | 4 UJ          | 41            | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID       | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|----------------|-------------------|--------------------------------------|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 20-019-WR-1DUP | 1.76              | 55                                   | 550                           | 495                                       | <0.01                  | 2.25                   | 2.45                   | 70.3                                      | 479                                       |
| 20-019-WR-1    | 1.77              | 55.3                                 | 548                           | 492                                       | <0.01                  | 2.24                   | 2.44                   | 70  | 478                                       |
| 20-019-WR-2    | 0.15              | 4.69                                 | 562                           | 558                                       | <0.01                  | 0.9                    | 0.81                   | 28.1                                      | 534                                       |

**LEGEND**

WR1 - Composite of subsamples WR1A, 1E, and 2.  
WR2 - Composite of subsamples WR1B, 1C, and 1D.  
BACKGROUND - From the Granite Mountain Mine  
(20-110-SS-1).  
WR1DUP - Duplicate of the 20-019-WR-1 sample.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Trout</u>                          | County: <u>Granite</u>                     |
| Legal Description: <u>T 7N R 13W</u>                  | Section(s): <u>NE 1/4, SE 1/4, Sec. 30</u> |
| Mining District: <u>Philipsburg</u>                   | Mine Type: <u>Hardrock/Au, Ag, Pb Zn</u>   |
| Latitude: <u>N 46° 19' 48"</u>                        | Primary Drainage: <u>Cliff Gulch</u>       |
| Longitude: <u>W 113° 16' 05"</u>                      | USGS Code: <u>17010202</u>                 |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Cliff Gulch</u>     |
| Quad: <u>Philipsburg</u>                              | Date Investigated: <u>June 21, 1993</u>    |
| Inspectors: <u>Bullock, Flammang, Clark</u>           | P.A. # <u>20-062</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were approximately 93,000 cubic yards of mostly uncovered tailings on site. The following elements were elevated at least three times background:

|                                   |                         |
|-----------------------------------|-------------------------|
| Arsenic: 95J to 285J mg/kg        | Barium: 1,340 mg/kg     |
| Cadmium: 6.5 to 26.7 mg/kg        | Chromium: 24 mg/kg      |
| Copper: 156 to 376 mg/kg          | Mercury: 1.83JX mg/kg   |
| Manganese: 16,900 to 19,500 mg/kg | Nickel: 79 to 110 mg/kg |
| Lead: 946 to 2,780 mg/kg          | Antimony: 33J mg/kg     |
| Zinc: 3,090 to 14,500 mg/kg       |                         |
- There were approximately 1,750 cubic yards of slag on site. The following elements were elevated at least three times background:

|                        |                         |
|------------------------|-------------------------|
| Arsenic: 663J mg/kg    | Cadmium: 7.2 mg/kg      |
| Chromium: 17.7 mg/kg   | Copper: 47.2 mg/kg      |
| Mercury: 0.882JX mg/kg | Manganese: 97,200 mg/kg |
| Nickel: 387 mg/kg      | Zinc: 4,850 mg/kg       |
- There were approximately 18,140 cubic yards of mostly uncovered waste rock on site. The following elements were elevated at least three times background:

|                              |                             |
|------------------------------|-----------------------------|
| Arsenic: 218J to 615J mg/kg  | Cadmium: 3.1 to 19.1 mg/kg  |
| Chromium: 14.7 to 30.2 mg/kg | Copper: 38.9 to 323 mg/kg   |
| Mercury: 2.51JX mg/kg        | Manganese: 25,800 mg/kg     |
| Nickel: 111 mg/kg            | Lead: 3,680 mg/kg           |
| Antimony: 28J mg/kg          | Zinc: 1,480 to 11,200 mg/kg |
- There were no discharging adits, shafts, seeps or springs identified at the site.
- There was no surface water on site. The nearest surface water was over 1 mile away; no surface water samples were collected. A dry drainage was identified below the site and its headwaters were in the tailings; hence, there was no upstream sample. A downstream sediment sample was collected.



**Trout PA# 20-062**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/22/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | Cyanide (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 20-062-SE-1 | 303 J      | 2540       | 21.8       | 2.7        | 20.2       | 274        | 16800      | 1.23 JX    | 28300      | 131        | 2900       | 21 J       | 11200      | NR              |
| 20-062-SL-1 | 663 J      | 507        | 7.2        | 2.6        | 17.7       | 47.2       | 17400      | 0.882 JX   | 97200      | 387        | 1240       | 10 J       | 4850       | NR              |
| 20-062-TP-1 | 95 J       | 547        | 6.5        | 1.2 U      | 8.5        | 156        | 8690       | 0.412 JX   | 16900      | 79         | 946        | 5 J        | 3090       | NR              |
| 20-062-TP-2 | 285 J      | 1340       | 26.7       | 7.1        | 24         | 376        | 21400      | 1.83 JX    | 19500      | 110        | 2780       | 33 J       | 14500      | NR              |
| 20-062-WR-1 | 615 J      | 215        | 3.1        | 4.9        | 30.2       | 38.9       | 19300      | 0.335 JX   | 154000     | 723        | 198        | 7 J        | 1170       | NR              |
| 20-062-WR-2 | 218 J      | 605        | 19.1       | 0.8 U      | 5.8        | 223        | 3990       | 2.51 JX    | 25800      | 111        | 3680       | 28 J       | 11200      | NR              |
| 20-062-WR-3 | 10 J       | 39.5       | 9.8        | 4.7        | 14.7       | 323        | 15600      | 0.054 JX   | 581        | 12         | 13         | 4 UJ       | 1480       | NR              |
| BACKGROUND  | 25 J       | 286        | 0.5 U      | 9.8        | 4.6        | 9          | 13900      | 0.161 JX   | 1230       | 11         | 9          | 4 UJ       | 41         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID       | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|----------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 20-062-SL-1    | <0.01          | 0                              | 187                     | 187                              | <0.01            | <0.01            | 0.05             | 0                                | 187                              |
| 20-062-SL-1DUP | <0.01          | 0                              | 177                     | 177                              | <0.01            | 0.01             | 0.05             | 0.31                             | 177                              |
| 20-062-TP-1    | 0.92           | 28.7                           | 98                      | 69.2                             | 0.22             | 0.53             | 0.17             | 16.6                             | 81.4                             |
| 20-062-TP-2    | 2.17           | 67.8                           | 129                     | 61.4                             | <0.01            | 1.88             | 0.38             | 58.7                             | 70.4                             |
| 20-062-WR-1    | <0.01          | 0                              | 469                     | 469                              | <0.01            | <0.01            | 0.02             | 0                                | 469                              |
| 20-062-WR-2    | <0.01          | 0                              | 908                     | 908                              | <0.01            | <0.01            | 0.02             | 0                                | 908                              |
| 20-062-WR-3    | 1.8            | 56.2                           | 168                     | 112                              | 0.02             | 0.77             | 1.01             | 24.1                             | 144                              |

Cation Exchange Capacity

| FIELD ID    | milliequivalents/100g |
|-------------|-----------------------|
| 20-062-SL-1 | 4.19                  |
| 20-062-TP-1 | 0.62                  |
| 20-062-TP-2 | 3.79                  |

**LEGEND**

SE1 - Downgradient sediment sample in Cliff Gulch.  
SL1 - Dark material associated with old mill. Composite of subsamples SL-1, 2A, 2B, and 3.  
TP1 - Composite of subsamples TP1-1A, 2, and 3.  
TP2 - Composite of subsamples TP1-1B, 1C, 1D, and 2D.  
WR1 - Composite of subsamples WR1, 2, and LO#1.  
WR2 - Composite of subsamples WR4A, 4B, 5, and 6.  
WR3 - Sample of the subsample WR3.  
BACKGROUND - From the Granite Mountain Mine (20-110-SS-1).  
SL1DUP - Duplicate of the sample 20-062-SL1.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Granite Mountain</u>               | County: <u>Granite</u>                     |
| Legal Description: <u>T 7 N R 13 W</u>                | Section(s): <u>NE 1/4, SE 1/4, Sec. 32</u> |
| Mining District: <u>Philipsburg</u>                   | Mine Type: <u>Hardrock/Ag, Au, Pb</u>      |
| Latitude: <u>N 46° 18' 55" to 19' 05"</u>             | Primary Drainage: <u>Flint Creek</u>       |
| Longitude: <u>W 113° 14' 20" to 14' 50"</u>           | USGS Code: <u>17010202</u>                 |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Douglas Creek</u>   |
| Quad: <u>Fred Burr/Philipsburg</u>                    | Date Investigated: <u>June 22, 1993</u>    |
| Inspectors: <u>Tuesday, Belanger, Lasher</u>          | P.A. # <u>20-110</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- The volume of tailings associated with this site was estimated to be approximately 8,280 cubic yards. Tailings were also observed in a dry stream bed extending approximately 1 mile downstream to Douglas Creek. The following elements were elevated at least three times background:

|                        |                       |
|------------------------|-----------------------|
| Arsenic: 55,000J mg/kg | Mercury: 4.58JX mg/kg |
| Cadmium: 38.3 mg/kg    | Lead: 1,240 mg/kg     |
| Copper: 1,560 mg/kg    | Antimony: 224J mg/kg  |
| Iron: 298,000 mg/kg    | Zinc: 7,920 mg/kg     |
| Cyanide: 0.737 mg/kg   |                       |
- The volume of waste rock associated with this site was estimated to be approximately 53,000 cubic yards. The following elements were elevated at least three times background:

|                        |                    |
|------------------------|--------------------|
| Arsenic: 3,420 mg/kg   | Lead: 315 mg/kg    |
| Copper: 52.9 mg/kg     | Antimony: 28 mg/kg |
| Mercury: 1.67 JX mg/kg | Zinc: 289 mg/kg    |
- No flowing adits or filled shafts, were observed on or adjacent to the site during the investigation; no groundwater or surface water samples were collected.
- The fenced shaft was open and potentially hazardous. A highwall located near the top of the hill was unstable and potentially hazardous.

**Granite Mountain PA# 20-110**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 06/22/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 20-110-TP-2 | 55000 J       | 98.4          | 38.3          | 4.9           | 10.4          | 1560          | 298000        | 4.58 JX       | 1990          | 11            | 1240          | 224 J         | 7920          | 0.737              |
| 20-110-WR-1 | 3420 J        | 232           | 1.3           | 4.3           | 1.8           | 52.9          | 21200         | 1.67 JX       | 1090          | 6             | 315           | 28 J          | 289           | NR                 |
| BACKGROUND  | 25 J          | 286           | 0.5 U         | 9.8           | 4.6           | 9             | 13900         | 0.161 JX      | 1230          | 11            | 9             | 4 UJ          | 41            | NR                 |

U - Not Detected; J - Estimated Quantity, X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID       | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL.<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|----------------|-------------------|--------------------------------------|--------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 20-110-TP-2    | 0.72              | 22.5                                 | -2.3                           | -25                                       | 0.1                    | 0.47                   | 0.15                   | 14.7                                      | -17                                       |
| 20-110-WR-1DUP | 0.43              | 13.4                                 | 2.02                           | -11                                       | 0.34                   | <0.01                  | 0.09                   | 0   | 2.02                                      |
| 20-110-WR-1    | 0.41              | 12.8                                 | 2.37                           | -10                                       | 0.31                   | 0.01                   | 0.09                   | 0.31                                      | 20.6                                      |

**LEGEND**

TP2 - Sample of the TP2 subsample.  
WR1 - Composite of WR1A, 1B, 1C, 1D, and 1E.  
BACKGROUND - From Granite Mountain Mine (20-110-SS-1).  
WR1DUP - Duplicate of sample 20-110-WR-1.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>True Fissure</u>                   | County: <u>Granite</u>                     |
| Legal Description: <u>T 7N R 13W</u>                  | Section(s): <u>NE 1/4, SE 1/4, Sec. 30</u> |
| Mining District: <u>Philipsburg</u>                   | Mine Type: <u>Hardrock/Ag, Mn, Pb, Zn</u>  |
| Latitude: <u>N 46° 19' 32"</u>                        | Primary Drainage: <u>Douglas Creek</u>     |
| Longitude: <u>W 113° 16' 00"</u>                      | USGS Code: <u>17010202</u>                 |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Camp Creek</u>      |
| Quad: <u>Philipsburg</u>                              | Date Investigated: <u>June 23, 1993</u>    |
| Inspectors: <u>Tuesday, Belanger, Clark</u>           | P.A. # <u>20-111</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be 106,300 cubic yards. The following elements were elevated at least three times background:

|                              |                            |
|------------------------------|----------------------------|
| Arsenic: 502 mg/kg           | Cadmium: 2.3 to 3.6 mg/kg  |
| Copper: 43.4J to 43.7J mg/kg | Manganese: 34,900 mg/kg    |
| Nickel: 142J mg/kg           | Lead: 347J to 1,140J mg/kg |
| Zinc: 1,730 to 2,420 mg/kg   |                            |
- The waste rock dumps were undercut for use as fill material, and resulted in unstable highwalls on WR-4. A residence was located at the base of WR-1.
- No observed releases or exceedances of drinking water standards or aquatic life criteria were documented during this investigation. No adit discharges, seeps or springs were observed.
- Two hazardous structures were on site: one older building and an old covered tramway. Two mine openings were on site: an adit closed by Department of State Lands (DSL), and a shaft fenced by DSL but still open.



**True Fissure PA# 20-111**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 06/23/93**

| SOLID MATRIX ANALYSES   |                      |   |                               |   |                        |                        |                        |   |   |   |               |               |               |                    |
|---|----------------------|---|-------------------------------|---|------------------------|------------------------|------------------------|---|---|---|---------------|---------------|---------------|--------------------|
| Metals in soils<br>Results per dry weight basis   |                      |   |                               |   |                        |                        |                        |   |   |   |               |               |               |                    |
| FIELD ID  | As<br>(mg/Kg)        | Ba<br>(mg/Kg)                           | Cd<br>(mg/Kg)                 | Co<br>(mg/Kg)                             | Cr<br>(mg/Kg)          | Cu<br>(mg/Kg)          | Fe<br>(mg/Kg)          | Hg<br>(mg/Kg)                             | Mn<br>(mg/Kg)                             | Ni<br>(mg/Kg)   | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
| 20-111-WR-1   | 74                   | 88.3                                    | 3.6                           | 3   | 6.1                    | 43.4 J                 | 6960                   | 0.244                                     | 34900                                     | 142 J   | 347 J         | 8 J           | 2420          | NR                 |
| 20-111-WR-2   | 502                  | 227                                     | 2.3                           | 6.2                                       | 4.4                    | 43.7 J                 | 37800                  | 1.88                                      | 342                                       | 2 U   | 1140 J        | 5 J           | 1730          | NR                 |
| BACKGROUND  | 25 J                 | 286                                     | 0.5 U                         | 9.8                                       | 4.6                    | 9                      | 13900                  | 0.161 JX                                  | 1230                                      | 11  | 9             | 4 UJ          | 41            | NR                 |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                      |   |                               |   |                        |                        |                        |   |   |   |               |               |               |                    |
| Acid/Base Accounting  |                      |   |                               |   |                        |                        |                        |   |   | LEGEND  |               |               |               |                    |
| FIELD ID  | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | WR1 - Composite of subsamples WR1A through 1C, 4A, and 4B.<br>WR2 - Composite of subsamples WR2A and 3A.<br>BACKGROUND - From the Granite Mountain Mine (20-110-SS-1) |               |               |               |                    |
| 20-111-WR-1   | 0.34                 | 10.6                                    | 595                           | 584                                       | <0.01                  | 0.44                   | 0.34                   | 13.7                                      | 581                                       |   |               |               |               |                    |
| 20-111-WR-2   | 0.75                 | 23.4                                    | 1.44                          | -22                                       | 0.57                   | 0.04                   | 0.14                   | 1.25                                      | 0.19                                      |   |               |               |               |                    |

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Nonpareil  
Legal Description: T 8 N R 12 W  
Mining District: South Boulder  
Latitude: N 46° 23' 53"  
Longitude: W 113° 08' 20"  
Land Status: Private/Public  
Quad: Maxville  
Inspectors: M. Babits, S. Babits/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Granite  
Section(s): SW 1/4, SW 1/4, Sec. 32  
Mine Type: Hardrock/Pb, Ag, Zn, Cu  
Primary Drainage: Flint Creek  
USGS Code: 17010202  
Secondary Drainage: Boulder Creek  
Date Investigated: September 8, 1993  
P.A. # 20-012

- There were approximately 1,445 cubic yards of tailings on site. The following were elevated at least three times background:

|                               |                             |
|-------------------------------|-----------------------------|
| Arsenic: 360 to 697 mg/kg     | Barium 433 mg/kg            |
| Cadmium: 23.1 to 45.8 mg/kg   | Copper: 159 to 316 mg/kg    |
| Mercury: 1.22 mg/kg           | Lead: 2,640 to 3,110 mg/kg  |
| Antimony: 243J to 282J mg/kg  | Zinc: 3,260 to 12,100 mg/kg |
| Cyanide: 0.395 to 0.541 mg/kg |                             |
- There were approximately 3,200 cubic yards of uncovered waste rock. The following were elevated at least three times background:

|                      |                    |
|----------------------|--------------------|
| Arsenic: 2,330 mg/kg | Copper: 863J mg/kg |
| Iron: 176,000 mg/kg  | Lead: 5,720 mg/kg  |
| Antimony: 116J mg/kg | Zinc: 3,310 mg/kg  |
- There were no discharging adits, filled shafts, seeps, or springs identified at the site.
- Boulder Creek was flowing approximately 200 feet west of the site. Water which flowed directly through the tailings discharged into Boulder Creek. An observed release to Boulder Creek was documented for copper; however, no MCLs or acute or chronic aquatic life criteria were exceeded that were attributable to the site.

**Nonpareil PA# 20-012**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 09/08/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 20-012-SE-1 | 54.1       | 28.9 J     | 4.6        | 3.37 J     | 3.23       | 42.7 J     | 7660       | 0.751      | 195 J      | 6.97       | 97.2       | 6.1 UJ     | 1020       | NR              |
| 20-012-SE-2 | 177        | 139 J      | 7.9        | 5.76 J     | 5.57       | 69.8 J     | 18400      | 0.719      | 702 J      | 11.7       | 754        | 42.5 J     | 1380       | NR              |
| 20-012-TP-1 | 360        | 433 J      | 23.1       | 1.64 U     | 2.16       | 159 J      | 14900      | 1.22       | 9.66 J     | 2.13 U     | 3110       | 282 J      | 3260       | 0.395           |
| 20-012-TP-2 | 697        | 319 J      | 45.8       | 8.89 J     | 4.09       | 316 J      | 29700      | 0.169      | 198 J      | 42.4       | 2640       | 243 J      | 12100      | 0.541           |
| 20-012-WR-1 | 2330       | 111 J      | 0.5 U      | 2.02 J     | 12.8       | 863 J      | 176000     | 1.78       | 119 J      | 5.85       | 5720       | 116 J      | 3310       | NR              |
| BACKGROUND  | 17 JX      | 122        | 0.8 J      | 10.4 J     | 34.2 J     | 34.6       | 23500 J    | 0.06       | 1040 J     | 36 J       | 38 J       | 5 U        | 106 J      | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 20-012-TP-1 | 0.84           | 26.2                           | 1.51                    | -25                              | 0.63             | 0.06             | 0.15             | 1.87                             | -0.36                            |
| 20-012-TP-2 | 2.65           | 82.8                           | 11.7                    | -71                              | 0.6              | 1.76             | 0.29             | 55                               | -43.3                            |
| 20-012-WR-1 | 0.53           | 16.6                           | -0.3                    | -17                              | 0.51             | <0.01            | 0.02             | 0                                | -0.28                            |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co    | Cr     | Cu     | Fe   | Hg       | Mn     | Ni      | Pb   | Sb     | HARDNESS CALC. Zn (mg CaCO3/L) |
|-------------|------|------|--------|-------|--------|--------|------|----------|--------|---------|------|--------|--------------------------------|
| 20-012-SW-1 | 1.79 | 15.1 | 4.27 J | 9.7 U | 6.83 U | 2.9 J  | 48.2 | 0.12 UJX | 4.08 U | 15.1 JX | 3.73 | 30.7 U | 16.9 J 76.3                    |
| 20-012-SW-2 | 2.86 | 21   | 2.57 U | 9.7 U | 6.83 U | 8.87 J | 75.3 | 0.13 JX  | 4.13   | 12.7 UX | 7    | 30.7 U | 37.1 J 80.6                    |
| 20-012-SW-3 | 5.13 | 32.6 | 2.57 U | 9.7 U | 6.83 U | 9.4 J  | 99.4 | 0.12 UJX | 4.13   | 12.7 UX | 6.69 | 30.7 U | 67.2 J 93.8                    |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 20-012-SW-1 | 130                    | < 5.0    | < 5.0   | < 0.05    | NR      |
| 20-012-SW-2 | 144                    | < 5.0    | < 5.0   | < 0.05    | NR      |
| 20-012-SW-3 | 155                    | < 5.0    | 9       | < 0.05    | NR      |

**LEGEND**

SE1 - Upgradient (100' from mill building in Boulder Creek. Just upgradient of pump house.  
SE2 - At PPE of pond discharge to Boulder Creek.  
TP1 - Composite of subsamples TP1, TP2, TP3, TP4A, and 4B.  
TP2 - Composite of subsamples TP5A and TP5B.  
WR1 - Composite of subsamples WR1A and WR1B.  
BACKGROUND - From Jackson Park (20-027-SS-1).

SW1 - Same as SE1.  
SW2 - Same as SE2.  
SW3 - Pond below Tailings Pond 5. (discharges into Boulder Creek)

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Brooklyn</u>                       | County: <u>Granite</u>                             |
| Legal Description: <u>T 7N R 12W</u>                  | Section(s): <u>SE 1/4, NW 1/4, Sec. 5</u>          |
| Mining District: <u>South Boulder</u>                 | Mine Type: <u>Hardrock/Ag, Cu, Pb, Zn, Bismuth</u> |
| Latitude: <u>N 46° 23' 23"</u>                        | Primary Drainage: <u>Flint Creek</u>               |
| Longitude: <u>W 112° 07' 30"</u>                      | USGS Code: <u>17010202</u>                         |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Boulder Creek</u>           |
| Quad: <u>Maxville/Pikes Peak</u>                      | Date Investigated: <u>June 24, 1993</u>            |
| Inspectors: <u>Bullock, Flammang, Lasher</u>          | P.A. # <u>20-025</u>                               |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- Two small impoundments were constructed between the upper mine workings and Boulder Creek. The waste material in these impoundments was either mill tailings or eroded waste rock from the waste rock dumps above. There was no evidence of a mill structure on site, and no historical accounts of milling on-site were found. There were approximately 4800 cubic yards of waste material in the impoundment area. The following elements were elevated at least three times background:

|                      |                    |
|----------------------|--------------------|
| Arsenic: 668 mg/kg   | Barium: 861J mg/kg |
| Cadmium: 99.3 mg/kg  | Copper: 2290 mg/kg |
| Mercury: 10.4J mg/kg | Lead: 5650 mg/kg   |
| Antimony: 747 mg/kg  | Zinc: 13,500 mg/kg |
- The volume of waste rock associated with this site was estimated to be approximately 38,000 cubic yards. The following elements were elevated at least three times background:

|                              |                          |
|------------------------------|--------------------------|
| Arsenic: 388 to 797 mg/kg    | Barium: 435J mg/kg       |
| Cadmium: 38.7 to 41.4 mg/kg  | Copper: 121 to 566 mg/kg |
| Mercury: 2.2J to 20.8J mg/kg | Lead: 2030 to 5510 mg/kg |
| Antimony: 64 to 644 mg/kg    | Zinc: 648 to 9140 mg/kg  |
- There were no discharging adits or shafts associated with this site.
- Boulder Creek flowed along the base of the lower workings (WR-5 and WR-6). Observed releases were documented for mercury and lead. MCLs and MCLGs were not exceeded in the samples collected. The chronic aquatic life criteria for lead was exceeded and was be directly attributed to this site.



**Brooklyn PA# 20-025**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/24/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 20-025-SE-1 | 126        | 318 J      | 12.6       | 1.5        | 1.4        | 56.5       | 8610       | 1.52 J     | 42.4 J     | 8 J        | 537        | 63         | 1560       | NR              |
| 20-025-SE-2 | 17         | 40 J       | 1.2        | 3.5        | 2.6        | 8          | 9410       | 0.099 J    | 278 J      | 3 J        | 32         | 4 U        | 179        | NR              |
| 20-025-TP-1 | 668        | 861 J      | 99.3       | 3.8        | 5.7        | 2290       | 15900      | 10.4 J     | 18.2 J     | 16 J       | 5650       | 747        | 13500      | NR              |
| 20-025-WR-2 | 466        | 294 J      | 38.7       | 3.9        | 3.5        | 566        | 17700      | 12.6 J     | 43.9 J     | 15 J       | 5510       | 644        | 9140       | NR              |
| 20-025-WR-3 | 797        | 227 J      | 3          | 6.3        | 3          | 121        | 54300      | 2.2 J      | 43.4 J     | 15 J       | 2030       | 64         | 648        | NR              |
| 20-025-WR-5 | 388        | 435 J      | 41.4       | 4.4        | 2.5        | 213        | 17600      | 20.8 J     | 45.1 J     | 80 J       | 3310       | 184        | 3180       | NR              |
| BACKGROUND  | 17 JX      | 122        | 0.8 J      | 10.4 J     | 34.2 J     | 34.6       | 23500 J    | 0.06       | 1040 J     | 36 J       | 38 J       | 5 U        | 106 J      | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 20-025-TP-1 | 3.29           | 103                            | -1.6                    | -104                             | 0.96             | 1.25             | 1.08             | 39                               | -40.6                            |
| 20-025-WR-2 | 1.81           | 56.5                           | 5.7                     | -51                              | 0.49             | 0.29             | 1.03             | 9.06                             | -3.36                            |
| 20-025-WR-3 | 5.07           | 158                            | 42.1                    | -116                             | 0.88             | 2.62             | 1.57             | 81.8                             | -39.7                            |
| 20-025-WR-5 | 1.65           | 51.5                           | 165                     | 114                              | 0.1              | 0.46             | 1.09             | 14.4                             | 151                              |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co    | Cr     | Cu     | Fe   | Hg      | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. Zn (mg CaCO3/L) |
|-------------|------|------|--------|-------|--------|--------|------|---------|------|--------|--------|--------|-----------------|--------------------------------|
| 20-025-SW-1 | 2.88 | 13.4 | 2.57 U | 9.7 U | 6.83 U | 2.33   | 110  | 0.067   | 6.2  | 12.7 U | 9.39   | 30.7 U | 7.57 U          | 51.5                           |
| 20-025-SW-2 | 1.24 | 10.5 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 25.5 | 0.038 U | 4.43 | 12.7 U | 0.38 U | 30.7 U | 7.57 U          | 51.8                           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 20-025-SW-1 | 95                     | < 5.0    | 5       | < 0.05    | NR      |
| 20-025-SW-2 | 96                     | < 5.0    | 5       | < 0.05    | NR      |

**LEGEND**

SE1 - Downgradient of waste rock dump 5 and 6.  
SE2 - Upgradient of mine.  
TP1 - Composite of subsamples TP1A-A 1A-B, 1B-A, 1B-B, and 1B-C.  
WR2 - Composite of subsamples WR1, 2A, 2B, and 2C.  
WR3 - Composite of subsamples WR3A, 3B, 3C, and 3D.  
WR5 - Composite of subsamples WR5A, 5B, 6A, 6B, and 6C.  
BACKGROUND - From the Jackson Park Mine (20-027-SS-1).

SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Middle Fork Warm Springs</u>       | County: <u>Jefferson</u>                            |
| Legal Description: <u>T 8 N R 2 W</u>                 | Section(s): <u>SE 1/4, SE 1/4, Sec. 30, SW 1/4,</u> |
| Mining District: <u>Alhambra</u>                      | <u>SW 1/4, Sec. 29</u>                              |
| Latitude: <u>N 46° 25' 00"</u>                        | Mine Type: <u>Hardrock/Unknown</u>                  |
| Longitude: <u>W 111° 53' 48"</u>                      | Primary Drainage: <u>Warm Springs Creek</u>         |
| Land Status: <u>Public</u>                            | USGS Code: <u>10030101</u>                          |
| Quad: <u>Clancy</u>                                   | Secondary Drainage: <u>Middle Fork Warm</u>         |
| Inspectors: <u>Babits, Lasher, Flammang</u>           | <u>Springs Creek</u>                                |
| Organization: <u>Pioneer Technical Services, Inc.</u> | Date Investigated: <u>August 17, 1993</u>           |
|   | P.A. # <u>22-046</u>                                |

- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 17,700 cubic yards. The following elements were elevated at least three times background:

|                                  |                            |
|----------------------------------|----------------------------|
| Arsenic: 3,010J to 24,000J mg/kg | Cadmium: 5J to 7.3J mg/kg  |
| Mercury: 0.189 to 0.273 mg/kg    | Lead: 992J to 2,550J mg/kg |
| Zinc: 523J to 1,350J mg/kg       | Copper: 93.8 to 252 mg/kg  |
- There were four discharging adits identified at the site. The adit discharges were sampled for field parameters only. The pH measurements ranged from 6.61 to 7.16.
- An unnamed tributary to Middle Fork Warm Springs Creek flowed directly through the waste rock material at the site. Observed releases to this tributary were documented for arsenic, cadmium, copper, lead, and zinc. The MCL for cadmium was exceeded in the downstream sample; this exceedance was directly attributable to the site. Acute and chronic aquatic life criteria for zinc and the chronic aquatic life criteria for copper were exceeded in the downstream sample; these exceedances were also directly attributable to the site.
- One potentially hazardous open adit was identified at the site.

**Middle Fork Warm Springs PA# 22-046**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/17/93**

| SOLID MATRIX ANALYSES |                |                                |                          |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
|-----------------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|------------|------------|------------|------------|-----------------|
| Metals in soils       |                | Results per dry weight basis   |                          |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
| FIELD ID              | As (mg/Kg)     | Ba (mg/Kg)                     | Cd (mg/Kg)               | Co (mg/Kg)                       | Cr (mg/Kg)       | Cu (mg/Kg)       | Fe (mg/Kg)       | Hg (mg/Kg)                       | Mn (mg/Kg)                       | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 22-046-SE-1           | 7.43 J         | 23 J                           | 0.6 U                    | 5.53                             | 3.63             | 12.6             | 9220             | 0.031 U                          | 223                              | 4.51       | 9.5 U      | 7.21 U     | 28.4 J     | NR              |
| 22-046-SE-2           | 1130 J         | 37.9 J                         | 14.7 J                   | 13.4                             | 15.8             | 115              | 32500            | 0.206                            | 814                              | 7.71       | 263 J      | 7.59 U     | 1610 J     | NR              |
| 22-046-WR-1           | 5540 J         | 14.2 J                         | 0.7 J                    | 2.17 U                           | 1.53 U           | 63.4             | 24100            | 0.08                             | 41.4                             | 2.83 U     | 992 J      | 6.86 U     | 188 J      | NR              |
| 22-046-WR-2           | 3010 J         | 12.9 J                         | 0.5 U                    | 3.5                              | 1.38 U           | 114              | 30100            | 0.189                            | 295                              | 2.55 U     | 2450 J     | 6.18 U     | 523 J      | NR              |
| 22-046-WR-3           | 4290 J         | 9.29 J                         | 5.0 J                    | 1.86 U                           | 1.61             | 93.8             | 30400            | 0.273                            | 453                              | 2.43 U     | 1890 J     | 5.89 U     | 1350 J     | NR              |
| 22-046-WR-4           | 24000 J        | 8.4 J                          | 7.3 J                    | 10.9                             | 3.55             | 252              | 68600            | 0.027 U                          | 1200                             | 7.77       | 2550 J     | 6.07 U     | 1100 J     | NR              |
| BACKGROUND            | 32.1 J         | 77.7 J                         | 0.9 J                    | 14.1                             | 16.8             | 29.2             | 27200            | 0.03 U                           | 587                              | 9.28       | 52.7 J     | 5.46 U     | 116 J      | NR              |
| Acid/Base Accounting  |                |                                |                          |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
| FIELD ID              | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |            |            |            |            |                 |
| 22-046-WR-1           | 0.25           | 7.81                           | -6.12                    | -13.9                            | 0.24             | <0.01            | 0.01             | 0.00                             | -6.12                            |            |            |            |            |                 |
| 22-046-WR-2           | 0.74           | 23.1                           | -1.81                    | -24.9                            | 0.66             | 0.02             | 0.06             | 0.62                             | -2.44                            |            |            |            |            |                 |
| 22-046-WR-3           | 1.19           | 37.2                           | 7.71                     | -29.5                            | 0.56             | 0.25             | 0.38             | 7.81                             | -0.10                            |            |            |            |            |                 |
| 22-046-WR-4           | 6.65           | 208                            | 10.4                     | -197                             | 1.60             | 1.59             | 3.46             | 49.7                             | -39.2                            |            |            |            |            |                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

| WATER MATRIX ANALYSES |                        |                 |         |           |         |        |      |        |      |        |        |        |                 |                |
|-----------------------|------------------------|-----------------|---------|-----------|---------|--------|------|--------|------|--------|--------|--------|-----------------|----------------|
| Metals in Water       |                        | Results in ug/L |         |           |         |        |      |        |      |        |        |        |                 |                |
| FIELD ID              | As                     | Ba              | Cd      | Co        | Cr      | Cu     | Fe   | Hg     | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
| 22-046-SW-1           | 2.5                    | 6.17            | 2.57 U  | 9.7 U     | 6.83 U  | 1.77 J | 67.5 | 0.25 J | 6.07 | 12.7 U | 0.72 U | 30.7 U | 13.3            | 28.1           |
| 22-046-SW-2           | 23.1                   | 8.27            | 8.27 J  | 9.7 U     | 6.83 U  | 12.8 J | 337  | 0.21 J | 317  | 12.7 U | 2.22   | 30.7 U | 1290            | 101            |
| Wet Chemistry         |                        |                 |         |           |         |        |      |        |      |        |        |        |                 |                |
| FIELD I.D.            | TOTAL DISSOLVED SOLIDS | CHLORIDE        | SULFATE | NO3/NO2-N | CYANIDE |        |      |        |      |        |        |        |                 |                |
| 22-046-SW-1           | 81                     | < 5.0           | 9       | < 0.05    | NR      |        |      |        |      |        |        |        |                 |                |
| 22-046-SW-2           | 176                    | < 5.0           | 61      | < 0.05    | NR      |        |      |        |      |        |        |        |                 |                |

**LEGEND**

SE1 - Upgradient (200') on unnamed tributary of Middle Fork Warm Springs.  
 SE2 - Downgradient (150') on unnamed tributary of Middle Fork Warm Springs.  
 WR1 - Composite of subsamples WR5B and 5C.  
 WR2 - Composite of subsamples WR5A, 6A, and 6B.  
 WR3 - Composite of subsamples WR1, 2, 3A, and 3B.  
 WR4 - Composite of subsample WR4A and 4B.

BACKGROUND - 50 feet South and East of SW-1  
 SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Alhambra Hot Springs  
Legal Description: T 8 N R 3 W  
Mining District: Alhambra  
Latitude: N 46° 27' 05"  
Longitude: W 111° 59' 02"  
Land Status: Private/Public  
Quad: Clancy  
Inspectors: Babits, Flammang, Lasher  
Organization: Pioneer Technical Services, Inc.

County: Jefferson  
Section(s): NW 1/4, NE 1/4, Sec. 16  
Mine Type: Hardrock/Gravel  
Primary Drainage: Prickly Pear Creek  
USGS Code: 10030101  
Secondary Drainage: Warm Springs Creek  
Date Investigated: August 17, 1993  
P.A. # 22-049

- No mill tailings were observed at the site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 5,560 cubic yards. The following elements were elevated at least three times background:

|                            |                              |
|----------------------------|------------------------------|
| Barium: 310J to 529J mg/kg | Mercury: 0.473 to 2.26 mg/kg |
| Lead: 4,260 mg/kg          | Antimony: 17.5J mg/kg        |
- No discharging adits, filled shafts, seeps, or springs were observed at the site during the investigation.
- Warm Springs Creek was flowing approximately 300 feet south of the site; however, no surface water or sediment samples were collected due to lack of a direct runoff route.
- A potentially hazardous 10 foot highwall was identified above the upper waste rock dump.



**Alhambra Hot Springs PA# 22-049**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/17/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
 Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 22-049-WR-1 | 21.2 J        | 310 J         | 1.2 J         | 1.66 U        | 1.17 U        | 171           | 3650          | 2.26          | 53.7          | 2.17 U        | 4260 J        | 17.5 J        | 148 J         | NR                 |
| 22-049-WR-2 | 14.3 J        | 529 J         | 1.4 J         | 4.75          | 1.18 U        | 10.2          | 9920          | 0.473         | 288           | 3.43          | 106 J         | 5.3 U         | 66.1 J        | NR                 |
| BACKGROUND  | 32.1 J        | 77.7 J        | 0.9 J         | 14.1          | 16.8          | 29.2          | 27200         | 0.03 U        | 587           | 9.28          | 52.7 J        | 5.46 U        | 116 J         | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 22-049-WR-1 | 0.07              | 2.19                                 | 1.43                          | -0.76                                     | 0.02                   | <0.01                  | 0.05                   | 0.00                                      | 1.43                                      |
| 22-049-WR-2 | 0.05              | 1.56                                 | 4.30                          | 2.74                                      | 0.03                   | <0.01                  | 0.02                   | 0.00                                      | 4.30                                      |

**LEGEND**

WR1 - Sample of subsample WR1.  
 WR2 - Composite of subsamples WR2, 3A, and 3B.  
 BACKGROUND - From Middle Fork Warm Springs.  
 (22-046-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Solar Silver</u>                   | County: <u>Jefferson</u>   |
| Legal Description: <u>T 8 N R 2 W</u>                 | Section(s): <u>SE 1/4, SE 1/4, Sec. 30</u>                                     |
| Mining District: <u>Warm Springs</u>                  | Mine Type: <u>Hardrock/Pb, Ag, Au</u>  |
| Latitude: <u>N 46° 25' 00"</u>                        | Primary Drainage: <u>Middle Fork Warm Springs Creek</u>                        |
| Longitude: <u>W 111° 53' 48"</u>                      | USGS Code: <u>10030101</u>   |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Unnamed tributary to Middle Fork Warm Springs Creek</u> |
| Quad: <u>Clancy</u>                                   | Date: <u>August 17, 1993</u>   |
| Inspectors: <u>Babits, Flammang, Lasher</u>           | P.A. # <u>22-054</u>   |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 1,700 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 2,760J mg/kg      Lead: 715J mg/kg  
Zinc: 667J mg/kg
- One discharging adit was observed at the site during the investigation. The discharge eventually flowed into an unnamed tributary of Middle Fork Warm Springs Creek. MCLs for arsenic and cadmium were exceeded in the adit discharge. Acute and chronic aquatic life criteria were exceeded for copper and zinc, and the chronic aquatic life criteria for iron was exceeded. The pH measurement in the adit discharge was 6.94.
- Middle Fork Warm Springs Creek flowed directly adjacent to the waste rock dump. Observed releases to Middle Fork Warm Springs Creek were documented for arsenic, lead, and zinc. The MCL for cadmium was exceeded in the downstream sample; however, the exceedance was not attributable to the site. Acute and chronic aquatic life criteria for zinc were exceeded in the downstream sample; these exceedances were directly attributable to the site.
- One potentially hazardous open adit was identified at the site.

**Solar Silver PA# 22-054**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/17/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 22-046-SE-2 | 1130 J     | 37.9 J     | 15 J       | 13.4       | 15.8       | 115        | 32500      | 0.206      | 814        | 7.71       | 263 J      | 7.59 U     | 1610 J     | NR              |
| 22-046-WR-5 | 2760 J     | 29.1 J     | 1 J        | 6.95       | 6.07       | 83         | 56800      | 0.037      | 720        | 3.4        | 715 J      | 6.91 U     | 667 J      | NR              |
| BACKGROUND  | 32.1 J     | 77.7 J     | 1 J        | 14.1       | 16.8       | 29.2       | 27200      | 0.03 U     | 587        | 9.28       | 52.7 J     | 5.46 U     | 116 J      | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 22-046-WR-5 | 1.37           | 42.8                           | -5.6                    | -48                              | 125              | <0.01            | 0.16             | 0                                | -5.55                            |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co    | Cr     | Cu     | Fe   | Hg     | Mn   | Ni     | Pb     | Sb     | HARDNESS CALC. Zn(mg CaCO3/L) |
|-------------|------|------|--------|-------|--------|--------|------|--------|------|--------|--------|--------|-------------------------------|
| 22-046-SW-1 | 2.5  | 6.17 | 2.57 U | 9.7 U | 6.83 U | 1.77 J | 67.5 | 0.25 J | 6.07 | 12.7 U | 0.72 U | 30.7 U | 13.3                          |
| 22-046-SW-2 | 23.1 | 8.27 | 8.27 J | 9.7 U | 6.83 U | 12.8 J | 337  | 0.21 J | 317  | 12.7 U | 2.22   | 30.7 U | 101                           |
| 22-046-SW-7 | 152  | 6.4  | 10.9 J | 9.7 U | 6.83 U | 108 J  | 4810 | 0.22 J | 1490 | 12.7 U | 5.03   | 30.7 U | 2250                          |

Wet Chemistry  
Results in mg/l

| FIELD ID.   | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 22-046-SW-1 | 81                     | < 5.0    | 9       | < 0.05    | NR      |
| 22-046-SW-2 | 176                    | < 5.0    | 61      | < 0.05    | NR      |
| 22-046-SW-7 | 373                    | < 5.0    | 172     | < 0.05    | NR      |

**LEGEND**

SE1 - Upgradient on unnamed tributary (250') of Midd. Frk. Wrm. Sprgs.  
SE2 - Downgradient (150') unnamed tributary from waste rock dump 7.  
WR5 - Composite of subsamples WR7B and 7A.  
BACKGROUND - From the Middle Fork Warm Springs (22-046-SS-1).  
SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.  
SW7 - Adit discharge at waste rock dump 7.

NOTE: 22-046-WR-5 was collected and submitted to the lab under 22-046, not as 22-054 (Solar Silver).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Bullion</u>                        | County: <u>Jefferson</u>                      |
| Legal Description: T <u>7N</u> R <u>6W</u>            | Section(s): <u>SW 1/4, SE 1/4, Sec. 13</u>    |
| Mining District: <u>Basin</u>                         | Mine Type: <u>Hardrock/Au, Ag, Cu, Pb, Zn</u> |
| Latitude: <u>N 46° 21' 22"</u>                        | Primary Drainage: <u>Basin Creek</u>          |
| Longitude: <u>W 112° 17' 40"</u>                      | USGS Code: <u>10020006</u>                    |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Jack Creek</u>         |
| Quad: <u>Basin</u>                                    | Date Investigated: <u>July 6, 1993</u>        |
| Inspectors: <u>Bullock, Belanger, Clark</u>           | P.A. # <u>22-008</u>                          |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were approximately 4,200 cubic yards of tailings on site. The following elements were elevated at least three times background:

|                               |                                 |
|-------------------------------|---------------------------------|
| Arsenic: 2,440 to 4,470 mg/kg | Cadmium: 2.9 mg/kg              |
| Copper: 172 to 257 mg/kg      | Mercury: 0.373J to 0.575J mg/kg |
| Lead: 3,330J to 5,110J mg/kg  | Antimony: 151 to 196 mg/kg      |
  
- There were approximately 42,150 cubic yards of waste rock on site. The following were elevated at least three times background:

|                                  |                                 |
|----------------------------------|---------------------------------|
| Arsenic: 1,690J to 18,100J mg/kg | Cadmium: 4.1 mg/kg              |
| Copper: 137 to 372 mg/kg         | Mercury: 0.383J to 0.519J mg/kg |
| Lead: 3,610J to 11,300J mg/kg    | Antimony: 66 to 254 mg/kg       |
| Zinc: 695 mg/kg                  |                                 |
  
- There were two discharging adits on site. One entered surface water and was sampled as GW-1. This discharge had a flow rate of approximately 7 gpm, the pH was 2.92, and a specific conductance of 2610 umhos/cm. This discharge exceeded MCL/MCLGs for arsenic, cadmium, copper, nickel, and antimony. The chronic and acute aquatic life criteria for arsenic, cadmium, copper, lead, and zinc were exceeded. The chronic aquatic life criteria for iron was also exceeded.
  
- The tributary of Jack Creek received the adit discharge and flowed through the tailings. Observed releases were documented for arsenic, cadmium, copper, lead, and zinc. Arsenic and cadmium exceeded MCLs in the downstream surface water sample. Acute and chronic aquatic life criteria were exceeded for cadmium, copper, and zinc both upstream and downstream of the site. Observed releases to the stream sediments were also documented for arsenic, copper, lead, antimony, and zinc.
  
- There were no hazardous openings on site. There were five hazardous structures and three highwalls at pits or trenches.



**Bullion PA# 22-008**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/06/93**

**SOLID MATRIX ANALYSES**

| Metals in soils              |                |                                |                         |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
|------------------------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|------------|------------|------------|------------|-----------------|
| Results per dry weight basis |                |                                |                         |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
| FIELD ID                     | As (mg/Kg)     | Ba (mg/Kg)                     | Cd (mg/Kg)              | Co (mg/Kg)                       | Cr (mg/Kg)       | Cu (mg/Kg)       | Fe (mg/Kg)       | Hg (mg/Kg)                       | Mn (mg/Kg)                       | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 22-008-SE-1                  | 9 J            | 29.9                           | 0.5 U                   | 3.1                              | 4.1              | 6.6              | 7440             | 0.038 J                          | 163                              | 4          | 8 J        | 3 U        | 34         | NR              |
| 22-008-SE-2                  | 2180 J         | 48.1                           | 0.6 U                   | 11.6                             | 5.5              | 192              | 39200            | 0.062 J                          | 853                              | 13         | 179 J      | 15         | 313        | NR              |
| 22-008-SE-3                  | 1230 J         | 56.4                           | 0.9                     | 9                                | 7.4              | 146              | 18600            | 0.066 J                          | 396                              | 7          | 393 J      | 21         | 275        | NR              |
| 22-008-TP-1                  | 2440 J         | 88.9                           | 2.9                     | 2.2                              | 2.6              | 257              | 7260             | 0.203 J                          | 16.9                             | 4          | 3330 J     | 196        | 558        | NR              |
| 22-008-TP-2                  | 3420 J         | 118                            | 0.5 U                   | 1.1 U                            | 2.8              | 172              | 11600            | 0.575 J                          | 18.5                             | 2 U        | 3870 J     | 164        | 104        | NR              |
| 22-008-TP-3                  | 4470 J         | 40.6                           | 0.5 U                   | 14                               | 8.2              | 674              | 15100            | 0.373 J                          | 7.9                              | 4          | 5110 J     | 151        | 175        | NR              |
| 22-008-WR-1                  | 18100 J        | 138                            | 0.6 U                   | 1.7                              | 2.3              | 137              | 36700            | 0.383 J                          | 84.7                             | 2 U        | 3610 J     | 254        | 135        | NR              |
| 22-008-WR-2                  | 1690 J         | 22.5                           | 4.1                     | 2.1                              | 1 U              | 372              | 15800            | 0.519 J                          | 83.7                             | 2 U        | 11300 J    | 66         | 695        | NR              |
| BACKGROUND                   | 68 J           | 344                            | 0.6 U                   | 22.1                             | 20.3             | 35               | 35000            | 0.08 J                           | 6830                             | 21         | 39 J       | 5 U        | 188        | NR              |
| Acid/Base Accounting         |                |                                |                         |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
| FIELD ID                     | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |            |            |            |            |                 |
| 22-008-TP-1DUP               | 0.31           | 9.68                           | 0.42                    | -9.3                             | 0.14             | 0.09             | 0.08             | 2.81                             | -2.39                            |            |            |            |            |                 |
| 22-008-TP-1                  | 0.32           | 10                             | 0.58                    | -9.4                             | 0.15             | 0.08             | 0.09             | 2.5                              | -1.92                            |            |            |            |            |                 |
| 22-008-TP-2                  | 0.21           | 6.56                           | -0.9                    | -7.5                             | 0.19             | 0.01             | 0.01             | 0.31                             | -1.23                            |            |            |            |            |                 |
| 22-008-TP-3                  | 1.21           | 37.8                           | -3.3                    | -41                              | <0.01            | 1.24             | 0.1              | 38.7                             | -42                              |            |            |            |            |                 |
| 22-008-WR-1                  | 1.04           | 32.5                           | -2.6                    | -35                              | 0.93             | 0.02             | 0.09             | 0.62                             | -3.23                            |            |            |            |            |                 |
| 22-008-WR-2                  | 1.41           | 44                             | -4.4                    | -48                              | 1.1              | <0.01            | 0.33             | 0                                | -4.39                            |            |            |            |            |                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**WATER MATRIX ANALYSES**

| Metals in Water |                        |          |         |           |         |         |          |         |          |        |         |        |                 |                |
|-----------------|------------------------|----------|---------|-----------|---------|---------|----------|---------|----------|--------|---------|--------|-----------------|----------------|
| Results in ug/L |                        |          |         |           |         |         |          |         |          |        |         |        |                 |                |
| FIELD ID        | As                     | Ba       | Cd      | Co        | Cr      | Cu      | Fe       | Hg      | Mn       | Ni     | Pb      | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
| 22-008-GW-1     | 12700                  | 8.57     | 736     | 508       | 13.3 J  | 19400 J | 325000 J | 0.038 U | 31000 JX | 142    | 743 JX  | 147    | 80600 J         | 366            |
| 22-008-SW-1     | 2.02                   | 13.6     | 2.57 U  | 9.7 U     | 15 J    | 12.2 J  | 105 J    | 0.038 U | 4.6 JX   | 12.7 U | 4.96 JX | 30.7 U | 45.2 J          | 19.7           |
| 22-008-SW-2     | 208                    | 12.5     | 26.4    | 20.5      | 6.83 U  | 631 J   | 8470 J   | 0.038 U | 1200 JX  | 12.8   | 15.4 JX | 30.7 U | 2960 J          | 33.2           |
| 22-008-SW-3     | 92.5                   | 13.6     | 22.9    | 17.1      | 10.9 J  | 424 J   | 4280 J   | 0.038 U | 930 JX   | 12.7 U | 15.2 JX | 30.7 U | 2570 J          | 35.7           |
| Wet Chemistry   |                        |          |         |           |         |         |          |         |          |        |         |        |                 |                |
| FIELD I.D.      | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |         |          |         |          |        |         |        |                 |                |
| 22-008-GW-1     | 72                     | < 5.0    | < 5     | < 0.05    | NR      |         |          |         |          |        |         |        |                 |                |
| 22-008-SW-1     | 114                    | < 5.0    | 47      | < 0.05    | NR      |         |          |         |          |        |         |        |                 |                |
| 22-008-SW-2     | 137                    | < 5.0    | 47      | < 0.05    | NR      |         |          |         |          |        |         |        |                 |                |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**LEGEND**

SE1 - Upgradient on Jack Creek.  
 SE2 - PPE - Adit #6 discharge after flowing through dump.  
 SE3 - Downgradient Jack Creek; approx. 100' below TP2.  
 TP1 - Composite of subsamples TP1A-A, B, C, and TP1B-A, B.  
 TP2 - Composite of subsamples TP2A-A, B, and TP2B-A, B.  
 TP3 - Composite of subsamples TP1A-D, 2A-C, and 2B-C.  
 WR1 - Composite of subsamples WR2B, 2C, and 3B.  
 WR2 - Composite of subsamples WR5A, 5B, and 3D.  
 BACKGROUND - From the Bullion Mine (22-008-SS-1).  
 TP1DUP - Duplicate of sample 22-008-TP-1.  
 GW1 - Adit discharge above mill.  
 SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.  
 SW3 - Same as sample SE3.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Basin Millsite  
Legal Description: T 6 N R 5 W  
Mining District: Basin  
Latitude: N 46° 16' 17"  
Longitude: W 112° 15' 18"  
Land Status: Private  
Quad: Basin  
Inspectors: Babits, Lasher/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins

County: Jefferson  
Section(s): NE 1/4, SW 1/4, Sec. 17  
Mine Type: Millsite/Custom mill  
Primary Drainage: Boulder River  
USGS Code: 10020006  
Secondary Drainage: Basin Creek  
Date Investigated: July 9, 1993  
P.A. # 22-036

- The volume of tailings associated with this site was estimated to be approximately 19,000 cubic yards. The following elements were elevated at least three times background:

|                          |                                   |
|--------------------------|-----------------------------------|
| Arsenic: 2,840JX mg/kg   | Barium: 350 mg/kg                 |
| Cadmium: 27.7 mg/kg      | Copper: 252 mg/kg                 |
| Mercury: 0.585J mg/kg    | Manganese: 1,360J to 5,050J mg/kg |
| Lead: 102 to 3,340 mg/kg | Antimony: 37J mg/kg               |
| Zinc: 4,460 mg/kg        |                                   |
- The volume of waste rock associated with this site was estimated to be approximately 1,735 cubic yards. The following elements were elevated at least three times background:

|                               |                                 |
|-------------------------------|---------------------------------|
| Arsenic: 139JX to 232JX mg/kg | Cadmium: 38.5 to 103 mg/kg      |
| Copper: 342 to 963 mg/kg      | Mercury: 0.493J to 0.517J mg/kg |
| Manganese: 1,370J mg/kg       | Lead: 2,190 to 11,900 mg/kg     |
| Antimony: 35J to 329J mg/kg   | Zinc: 3,770 to 12,500 mg/kg     |
- No discharging adits, filled shafts, seeps, or springs were identified at the site.
- No surface water was flowing on or near the site during the investigation. The nearest surface water was over 1,000 feet away; no surface water samples were collected due to the lack of a direct runoff route.
- No hazardous mine openings were identified at the site.

**Basin Millsite PA# 22-036**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/09/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 22-036-TP-1 | 39 JX         | 43.5          | 0.5 U         | 3.6           | 11.9          | 25.5          | 10700         | 0.014 J       | 1360 J        | 4             | 102           | 6 UJ          | 135           | 0.308 U            |
| 22-036-TP-2 | 2840 JX       | 350           | 27.7          | 9.3           | 10.8          | 252           | 26900         | 0.585 J       | 5050 J        | 11            | 3340          | 37 J          | 4460          | 0.302 U            |
| 22-036-WR-1 | 232 JX        | 64.1          | 38.5          | 4.9           | 1.7           | 963           | 18900         | 0.493 J       | 672 J         | 6             | 11900         | 329 J         | 3770          | NR                 |
| 22-036-WR-2 | 139 JX        | 59.1          | 103           | 4.4           | 7.4           | 342           | 17300         | 0.517 J       | 1370 J        | 4             | 2190          | 35 J          | 12500         | NR                 |
| BACKGROUND  | 15            | 65.1          | 0.5 U         | 4             | 6.3 J         | 10.3 J        | 9160          | 0.01 J        | 344 J         | 6             | 11 JX         | 7 UJ          | 94            | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL.<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|--------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 22-036-TP-1 | <0.01             | 0                                    | 94.4                           | 94.4                                      | <0.01                  | <0.01                  | 0.04                   | 0   | 94.4                                      |
| 22-036-TP-2 | 1.69              | 52.8                                 | 114                            | 61.2                                      | 0.34                   | 1.12                   | 0.23                   | 35  | 79  |
| 22-036-WR-1 | 2.91              | 90.9                                 | 3.63                           | -87                                       | <0.01                  | 2.16                   | 0.84                   | 67.5                                      | -63.8                                     |
| 22-036-WR-2 | 2.19              | 68.4                                 | 9.8                            | -59                                       | 0.85                   | 0.63                   | 0.71                   | 19.7                                      | -9.88                                     |

**LEGEND**

TP1 - Composite of subsamples TP1A-A, -B, 1B-A, and -B.  
TP2 - Composite of subsamples TP1A-C, 1C-A, 1C-B, and 1C-C.  
WR1 - Composite of subsamples WR1, 2, 3, 4, 5, 6, and 7.  
WR2 - Same as sample 22-036-WR-1. (Split)  
BACKGROUND - From Morning Glory Mine (22-077-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Perry Park  
Legal Description: T 8 N R 6 W  
Mining District: Basin  
Latitude: N 46° 24' 03"  
Longitude: W 112° 18' 02"  
Land Status: Private/Public  
Quad: Three Brothers  
Inspectors: Babits, Bullock, Clark  
Organization: Pioneer Technical Services, Inc.

County: Jefferson  
Section(s): NW 1/4, SW 1/4, Sec. 36  
Mine Type: Placer/Au  
Primary Drainage: Basin Creek  
USGS Code: 1002006  
Secondary Drainage: Grub Gulch  
Date Investigated: July 9, 1993  
P.A. # 22-039

- No mill tailings were observed at this site during the investigation.
- No waste rock was observed at this site during the investigation.
- Approximately 22,000 cubic yards of placer dredgings were identified at the site. The material consisted of very large cobbles and boulders; consequently, no samples were collected.
- The dredged material was situated directly in Grub Gulch. A sediment sample did not indicate any metals values elevated above background. No surface water samples were collected.
- No hazardous mine openings or structures were identified at the site.



**Perry's Park PA# 22-039**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/09/93**

| SOLID MATRIX ANALYSES                           |               |               |               |               |               |               |               |               |               |               |               |               |               |                    |
|---|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| Metals in soils<br>Results per dry weight basis |               |               |               |               |               |               |               |               |               |               |               |               |               |                    |
| FIELD<br>ID                                     | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
| 22-039-SE-1                                     | 15 J          | 27.1          | 0.5 U         | 4.7           | 3.6           | 6.8           | 10000         | 0.028 J       | 428           | 4             | 8 J           | 4 U           | 66            | NR                 |
| BACKGROUND                                      | 88            | 76            | 0.7 U         | 9.5           | 10.9 J        | 49.7 J        | 20400         | 0.107 J       | 654 J         | 9             | 117 JX        | 8 UJ          | 104           | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**LEGEND**

SE1 - Grub Gulch below placer diggings approx. 300' above crossing.

BACKGROUND - From the Enterprise (22-074-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Buckeye</u>  | County: <u>Jefferson</u>                   |
| Legal Description: <u>T 8 N R 6 W</u>   | Section(s): <u>NW 1/4, SE 1/4, Sec. 36</u> |
| Mining District: <u>Basin</u>   | Mine Type: <u>Hardrock/Au</u>              |
| Latitude: <u>N 46° 23' 52"</u>  | Primary Drainage: <u>Basin Creek</u>       |
| Longitude: <u>W 112° 17' 38"</u>  | USGS Code: <u>10020006</u>                 |
| Land Status: <u>Private/Public</u>  | Secondary Drainage: <u>Basin Creek</u>     |
| Quad: <u>Three Brothers</u>   | Date Investigated: <u>July 6, 1993</u>     |
| Inspectors: <u>Babits, Lasher/Pierson</u>   | P.A. # <u>22-072</u>                       |
| Organization: <u>Pioneer Technical Services, Inc/<br/>Thomas Dean &amp; Hoskins, Inc.</u> |  |

- The volume of tailings associated with this site was estimated to be approximately 20,750 cubic yards. The following elements were elevated at least three times background:

|                                  |                            |
|----------------------------------|----------------------------|
| Arsenic: 708JX to 17,100JX mg/kg | Cadmium: 3.9 to 24.9 mg/kg |
| Copper: 168 to 1,160 mg/kg       | Lead: 417 to 14,100 mg/kg  |
| Antimony: 76J to 2,350J mg/kg    | Zinc: 1,250 to 4,040 mg/kg |
- The volume of waste rock associated with this site was estimated to be approximately 6,130 cubic yards. The following elements were elevated at least three times background:

|                        |                       |
|------------------------|-----------------------|
| Arsenic: 628JX mg/kg   | Mercury: 0.342J mg/kg |
| Manganese: 1,970 mg/kg | Lead: 1,850 mg/kg     |
| Antimony: 29J mg/kg    | Zinc: 340 mg/kg       |
- There were no discharging adits, filled shafts, seeps, or springs observed at the site during the investigation.
- Basin Creek flowed directly adjacent to the tailings. Surface water and sediment samples were collected upstream and downstream from the site. No MCLs were exceeded in the Basin Creek samples. Acute and chronic aquatic life criteria were exceeded for copper and zinc in the downstream sample; these exceedances were directly attributable to the site.
- No hazardous mine openings or structures were identified at the site.

**Buckeye PA# 22-072**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/06/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 22-074-SE-2 | 2360       | 30         | 1.2        | 10.5       | 12.6 J     | 60.6 J     | 47100      | 0.083 J    | 455 J      | 9          | 415 JX     | 42 J       | 208 JX     | NR              |
| 22-072-SE-3 | 997 JX     | 30.4       | 0.9        | 7.2        | 4.8        | 44.3       | 19200      | 0.056 J    | 488 J      | 6          | 589        | 74 J       | 253        | NR              |
| 22-072-TP-1 | 17100 JX   | 29.6       | 24.9       | 4          | 1.4        | 1160       | 24400      | 0.108 J    | 24.2 J     | 2 U        | 14100      | 2350 J     | 4040       | 0.271 U         |
| 22-072-TP-2 | 252 JX     | 224        | 3.9        | 16.2       | 17         | 168        | 16900      | 0.082 J    | 237 J      | 22         | 281        | 12 UJ      | 1250       | 0.577 U         |
| 22-072-TP-3 | 708 JX     | 74.4       | 0.9 U      | 5.2        | 7          | 51.2       | 6610       | 0.057 J    | 61.7 J     | 5 U        | 213        | 19 J       | 300        | 0.41 U          |
| 22-072-TP-4 | 7160 JX    | 66.4       | 0.4 U      | 5.6        | 3.8        | 17.9       | 21000      | 0.03 J     | 393 J      | 4          | 417        | 76 J       | 54         | 0.268 U         |
| 22-072-WR-1 | 628 JX     | 31         | 0.5 U      | 4.1        | 1.4 U      | 35         | 18600      | 0.342 J    | 1970 J     | 5          | 1850       | 29 J       | 340        | NR              |
| BACKGROUND  | 88         | 76         | 0.7 U      | 9.5        | 10.9 J     | 49.7 J     | 20400      | 0.107 J    | 654 J      | 9          | 117 JX     | 8 UJ       | 104        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID       | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|----------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 22-072-TP-1    | 2.45           | 76.5                           | -2                       | -79                              | 0.64             | 1.54             | 0.27             | 48.1                             | -50.1                            |
| 22-072-TP-2    | 0.31           | 9.68                           | -0.9                     | -11                              | 0.11             | 0.06             | 0.14             | 1.87                             | -2.79                            |
| 22-072-TP-3DUP | 0.09           | 2.81                           | 1.03                     | -1.8                             | 0.05             | 0.02             | 0.02             | 0.62                             | 0.4                              |
| 22-072-TP-3    | 0.09           | 2.81                           | 0.82                     | -2                               | 0.05             | 0.02             | 0.02             | 0.62                             | 0.19                             |
| 22-072-TP-4    | 0.04           | 1.25                           | -0.8                     | -2.1                             | 0.04             | <0.01            | <0.01            | 0                                | -0.81                            |
| 22-072-WR-1    | 0.87           | 27.2                           | 8.72                     | -19                              | 0.58             | 0.13             | 0.16             | 4.06                             | 4.66                             |
| 22-072-WR-1DUP | 0.88           | 27.5                           | 9.25                     | -18                              | 0.59             | 0.13             | 0.16             | 4.06                             | 5.19                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu     | Fe    | Hg      | Mn     | Ni     | Pb      | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. (mg CaCO3/L) |
|-------------|--------|------|--------|-------|--------|--------|-------|---------|--------|--------|---------|--------|-----------------|-----------------------------|
| 22-074-SW-2 | 10.1 J | 4.43 | 2.57 U | 9.7 U | 6.83 U | 6.23 J | 167   | 0.038 U | 143    | 12.7 U | 9.67 J  | 30.7 U | 129             | 23.3                        |
| 22-072-SW-3 | 18.1   | 5.53 | 2.57 U | 9.7 U | 9.27 J | 15.9 J | 284 J | 0.038 U | 161 JX | 12.7 U | 14.5 JX | 30.7 U | 165 J           | 25.9                        |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD I.D.  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 22-074-SW-2 | 80                     | < 5.0    | 8       | < 0.05    | NR      |
| 22-072-SW-3 | 89                     | < 5.0    | 8       | < 0.05    | NR      |

**LEGEND**

22-074-SE2 - In Basin Creek down oe PPE from Enterprise Mine.  
SE3 - Downgradient of PPE of tailings in Basin Creek.  
TP1 - Composite of subsamples TP1A-A, 1A-B, and 1B-A.  
TP2 - Composite of subsamples TP1B-B, 1B-C, 1C-B, and 1D-B.  
TP3 - Composite of subsamples TP1C-A and 1D-A.  
TP4 - Sample of TPE subsample.  
BACKGROUND - From the Enterprise Mine (22-074-SS-1).

SW3 - Same as sample SE3.  
22-074-SW2 - Same as 22-074-SE2 sample.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Enterprise  
Legal Description: T 8 N R 6 W  
Mining District: Basin  
Latitude: N 46° 23' 52"  
Longitude: W 112° 17' 38"  
Land Status: Public  
Quad: Three Brothers  
Inspectors: Babits, Lasher/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Jefferson  
Section(s): NW 1/4, SE 1/4, Sec. 36  
Mine Type: Hardrock/Au  
Primary Drainage: Basin Creek  
USGS Code: 10020006  
Secondary Drainage: Basin Creek  
Date Investigated: July 6, 1993  
P.A. # 22-074

- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 22,930 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 5,840 to 22,400 mg/kg    Lead: 1,000JX to 3,520JX mg/kg  
Antimony: 91J to 291J mg/kg
- One discharging adit was identified at the site. MCLs were exceeded for arsenic, copper, cadmium, and antimony in the adit discharge. Acute and chronic aquatic life criteria were exceeded for arsenic, cadmium, copper, lead, and zinc, and chronic aquatic life criteria were exceeded for iron and mercury. The pH measurement in the adit discharge was 2.9.
- The adit discharge entered Basin Creek downstream from the site. Surface water and sediment samples were collected from Basin Creek upstream and downstream from the adit discharge confluence. Acute and chronic aquatic life criteria were exceeded for copper and zinc in the downstream sample; these exceedances were directly attributable to the adit discharge.
- Observed releases to Basin Creek (sediment) were documented for arsenic, lead, and antimony, which were directly attributable to the site.
- No hazardous mine openings were identified at the site.



**Enterprise PA# 22-074**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/06/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 22-074-SE-1 | 15         | 29.2       | 0.6 U      | 8.1        | 5.7 J      | 12.9 J     | 15400      | 0.031 J    | 412 J      | 6          | 34 JX      | 7 UJ       | 95 JX      | NR              |
| 22-074-SE-2 | 2360       | 30         | 1.2        | 10.5       | 12.6 J     | 60.6 J     | 47100      | 0.083 J    | 455 J      | 9          | 415 JX     | 42 J       | 208 JX     | NR              |
| 22-074-WR-1 | 5840       | 81.5       | 0.9        | 2.2 U      | 2.3 J      | 62.4 J     | 37000      | 0.068 J    | 131 J      | 3 U        | 1000 JX    | 91 J       | 133 JX     | NR              |
| 22-074-WR-2 | 22400      | 24.4       | 1.4        | 2.1 U      | 1.4 UJ     | 94.6 J     | 33100      | 0.209 J    | 20.8 J     | 3 U        | 3520 JX    | 291 J      | 78 JX      | NR              |
| BACKGROUND  | 88         | 76         | 0.7 U      | 9.5        | 10.9 J     | 49.7 J     | 20400      | 0.107 J    | 654 J      | 9          | 117 JX     | 8 UJ       | 104 JX     | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 22-074-WR-1 | 0.38           | 11.9                           | -3.1                    | -15                              | 0.36             | <0.01            | 0.03             | 0                                | -3.1                             |
| 22-074-WR-2 | 2.97           | 92.8                           | -4.8                    | -98                              | 0.63             | 1.76             | 0.58             | 55                               | -59.8                            |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As      | Ba   | Cd     | Co    | Cr     | Cu     | Fe     | Hg      | Mn    | Ni     | Pb     | Sb     | Zn    | HARDNESS CALC. (mg CaCO3/L) |
|-------------|---------|------|--------|-------|--------|--------|--------|---------|-------|--------|--------|--------|-------|-----------------------------|
| 22-074-SW-1 | 3.71 J  | 4.27 | 2.57 U | 9.7 U | 6.83 U | 2.43 J | 99.7   | 0.130 J | 13.3  | 12.7 U | 5.42 J | 30.7 U | 12.9  | 23                          |
| 22-074-SW-2 | 10.1 J  | 4.43 | 2.57 U | 9.7 U | 6.83 U | 6.23 J | 167    | 0.038 U | 143   | 12.7 U | 9.67 J | 30.7 U | 129   | 23.3                        |
| 22-074-SW-4 | 15500 J | 13.9 | 146    | 42    | 6.83 U | 1340 J | 131000 | 0.081 J | 28900 | 31.7   | 1340 J | 84.2   | 23400 | 192                         |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 22-074-SW-1 | 43                     | < 5.0    | < 5     | < 0.05    | NR      |
| 22-074-SW-2 | 80                     | < 5.0    | 8       | < 0.05    | NR      |
| 22-074-SW-4 | 1050                   | < 5.0    | 622     | < 0.05    | NR      |

**LEGEND**

SE1 - Upgradient in Basin 100' above confluence with unnamed tributary.  
SE2 - In Basin Creek down of PPE of adit discharge.  
WR1 - Composite of subsamples WR2A and 2D.  
WR2 - Composite of subsamples WR2B and 2C.  
BACKGROUND - 300' upgradient from SW1. From Enterprise (22-074-SS-1).

SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.  
SW4 - Adit discharge.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Jack Creek Tailings</u>            | County: <u>Jefferson</u>                   |
| Legal Description: <u>T 7N R 6W</u>                   | Section(s): <u>SW 1/4, NE 1/4, Sec. 14</u> |
| Mining District: <u>Basin</u>                         | Mine Type: <u>Tailings</u>                 |
| Latitude: <u>N 46° 21' 42"</u>                        | Primary Drainage: <u>Basin Creek</u>       |
| Longitude: <u>W 112° 18' 27"</u>                      | USGS Code: <u>10020006</u>                 |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Jack Creek</u>      |
| Quad: <u>Basin</u>                                    | Date Investigated: <u>July 6, 1993</u>     |
| Inspectors: <u>Bullock, Belanger, Clark</u>           | P.A. # <u>22-296</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were approximately 23,000 cubic yards of tailings on site. The following elements were elevated at least three times background:

|                      |                           |
|----------------------|---------------------------|
| Arsenic: 1,890 mg/kg | Cadmium: 2.2 to 4.0 mg/kg |
| Copper: 381J mg/kg   | Lead: 147 to 681JX mg/kg  |
| Antimony: 26J mg/kg  |                           |
- There was no waste rock on site.
- There were no discharging mine openings, seeps, or springs identified at this site.
- Jack Creek ran through the tailings impoundment area. No observed releases to Jack Creek were documented; and no MCL/MCLGs were exceeded in upstream or downstream surface water samples. The acute aquatic life criteria was exceeded for lead in the downstream sample, which was directly attributable to the site.
- There were no hazardous openings on site.

**Jack Creek Tailings PA# 22-296**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/06/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 22-296-SE-1 | 573        | 31.5       | 4.2        | 12.9       | 16.1       | 127 J      | 26700      | 0.013 UJ   | 579        | 7 J        | 158        | 6 U        | 284 J      | NR              |
| 22-296-SE-2 | 263        | 24.2       | 1.7        | 7.6        | 3.1 J      | 83.1 J     | 8890       | 0.015 J    | 440 J      | 3 U        | 79 JX      | 8 UJ       | 201        | NR              |
| 22-296-TP-1 | 132        | 141        | 4.0        | 14.7       | 15.6       | 91.1 J     | 26800      | 0.044      | 402        | 21 J       | 147        | 6 U        | 348 J      | NR              |
| 22-296-TP-2 | 1890       | 67.2       | 2.2        | 8.4        | 7.5 J      | 381 J      | 21500      | 0.096 J    | 215 J      | 6          | 681 JX     | 26 J       | 323        | NR              |
| BACKGROUND  | 68 J       | 344        | 0.6 U      | 22.1       | 20.3       | 35         | 35000      | 0.08 J     | 6830       | 21         | 39 J       | 5 U        | 188        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 22-296-SE-1 | 0.03           | 0.94                           | 4.05                    | 3.12                             | 0.02             | <0.01            | 0.01             | 0                                | 4.05                             |
| 22-296-SE-2 | 0.01           | 0.31                           | 3.1                     | 2.79                             | <0.01            | <0.01            | 0.01             | 0                                | 3.1                              |
| 22-296-TP-1 | 0.08           | 2.5                            | 4.76                    | 2.26                             | 0.01             | 0.03             | 0.04             | 0.94                             | 3.82                             |
| 22-296-TP-2 | 0.08           | 2.5                            | 1.63                    | -0.9                             | 0.05             | 0.01             | 0.02             | 0.31                             | 1.32                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu     | Fe   | Hg      | Mn  | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|--------|-------|--------|--------|------|---------|-----|--------|--------|--------|-----------------|----------------|
| 22-296-SW-1 | 20.8 J | 13.1 | 3.83   | 9.7 U | 6.83 U | 63.6 J | 723  | 0.038 U | 145 | 12.7 U | 8.96 J | 30.7 U | 416             | 25.6           |
| 22-296-SW-2 | 36.5 J | 17.7 | 2.57 U | 9.7 U | 6.83 U | 65.2 J | 1170 | 0.038 U | 156 | 20.4   | 14.7 J | 30.7 U | 411             | 25.5           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 22-296-SW-1 | 58                     | < 5.0    | 10      | < 0.05    | NR      |
| 22-296-SW-2 | 54                     | < 5.0    | 14      | < 0.05    | NR      |

**LEGEND**

SE1 - Upgradient of tailings on Jack Creek.  
SE2 - Downgradient of tailings on Jack Creek.  
TP1 - Composite of subsamples TP1A-A, B, C, and TP1B-A, B, C.  
TP2 - Composite of subsamples TP1C-A, B, and TP1D-A.  
BACKGROUND - From the Bullion Mine (22-008-SS-1).

SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Marquerite  
Legal Description: T 6N R 5W  
Mining District: Basin  
Latitude: N 46° 18' 30"  
Longitude: W 112° 16' 28"  
Land Status: Private/Public  
Quad: Basin  
Inspectors: Babits, Lasher/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Jefferson  
Section(s): NE 1/4, NW 1/4, Sec. 6  
Mine Type: Hardrock/Au, Ag  
Primary Drainage: Basin Creek  
USGS Code: 10020006  
Secondary Drainage: Lily-of-the-West Gulch  
Date Investigated: July 9, 1993  
P.A. # 22-301

- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 580 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 70JX mg/kg                      Barium: 341 mg/kg  
Copper: 31.6 mg/kg                      Mercury: 1.24J mg/kg  
Lead: 422 mg/kg
- No discharging adits, filled shafts, seeps, or springs were identified at the site.
- No surface water was located on or near the site (the site was located well above the nearest drainage); consequently, no surface water or sediment samples were collected.
- One potentially hazardous partially open adit was identified at the site.



**Marguerite PA# 22-301**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/09/93**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 22-301-WR-1 | 70 JX      | 341        | 0.4 U      | 3.9        | 1.3 U      | 31.6       | 11000      | 1.24 J     | 302 J      | 3          | 422        | 11 J       | 83         | NR              |
| BACKGROUND  | 15         | 65.1       | 0.5 U      | 4          | 6.3 J      | 10.3 J     | 9160       | 0.01 J     | 344 J      | 6          | 11 JX      | 7 UJ       | 94         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 22-301-WR-1 | 0.05           | 1.56                           | 3.36                    | 1.8                              | 0.05             | <0.01            | <0.01            | 0                                | 3.36                             |

**WATER MATRIX ANALYSES**

**Metals in Water**  
**Results in ug/L**

| FIELD ID    | As     | Ba     | Cd     | Co    | Cr     | Cu     | Fe     | Hg      | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. Zn (mg CaCO3/L) |
|-------------|--------|--------|--------|-------|--------|--------|--------|---------|--------|--------|--------|--------|-----------------|--------------------------------|
| 22-301-SW-1 | 1.49 U | 2.01 U | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 11.8 U | 0.038 U | 4.08 U | 12.7 U | 4.14 J | 30.7 U | 7.57 U          | 0.2                            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**LEGEND**

WR1 - Composite of subsamples WR1 and 2.  
BACKGROUND - From Morning Glory (22-077-SS-1)  
SW1 - Bottle Blank.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |   |
|--|---|
| Mine/Site Name: <u>Mantle East</u>   | County: <u>Jefferson</u>                  |
| Legal Description: <u>T 6 N R 5 W</u>  | Section(s): <u>SE 1/4, NW 1/4, Sec. 9</u> |
| Mining District: <u>Cataract</u>   | Mine Type: <u>Hardrock-Underground/Au</u> |
| Latitude: <u>N 46° 17' 26"</u>   | Primary Drainage: <u>Boulder River</u>    |
| Longitude: <u>W 112° 14' 21"</u>   | USGS Code: <u>10020006</u>                |
| Land Status: <u>Private</u>  | Secondary Drainage: <u>Cataract Creek</u> |
| Quad: <u>Mount Thompson</u>  | Date Investigated: <u>July 7, 1993</u>    |
| Inspectors: <u>Babits, Lasher/Pierson</u>  | P.A. # <u>22-032</u>                      |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |   |

- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 4,148 cubic yards. The following elements were elevated at least three times background:

|                                 |                            |
|---------------------------------|----------------------------|
| Arsenic: 76JX mg/kg             | Copper: 38.4 to 66.6 mg/kg |
| Mercury: 0.208J to 0.254J mg/kg | Manganese: 1,110J mg/kg    |
| Lead: 114 to 288 mg/kg          |                            |
- No discharging adits, filled shafts, seeps, or springs were identified at the site during the investigation.
- WR-5 was situated directly in the Cataract Creek drainage. Sediment samples were collected from Cataract Creek upstream and downstream from the site; no observed releases were documented.
- No hazardous openings or structures were identified at the site.

**Mantle (East) PA# 22-032**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/07/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 22-032-SE-1 | 271 JX        | 79.2          | 9.5           | 17.1          | 6.9           | 360           | 17600         | 0.048 J       | 1070 J        | 6             | 232           | 12 J          | 889           | NR                 |
| 22-032-SE-2 | 144           | 45.8          | 7.4           | 16.7          | 3.8 J         | 254 J         | 8780          | 0.016 J       | 988 J         | 4             | 134 JX        | 9 J           | 580 JX        | NR                 |
| 22-032-WR-1 | 20 JX         | 38.5          | 0.6 U         | 8.6           | 1.7           | 38.4          | 11000         | 0.208 J       | 1110 J        | 7             | 114           | 7 UJ          | 136           | NR                 |
| 22-032-WR-2 | 76 JX         | 52.3          | 0.6 U         | 8.4           | 2.6           | 66.6          | 18000         | 0.254 J       | 1020 J        | 5             | 288           | 7 UJ          | 278           | NR                 |
| BACKGROUND  | 15            | 65.1          | 0.5 U         | 4             | 6.3 J         | 10.3 J        | 9160          | 0.01 J        | 344 J         | 6             | 11 JX         | 7 UJ          | 94            | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 22-032-WR-1 | 0.19              | 5.94                                 | 6.71                          | 0.77                                      | 0.08                   | 0.03                   | 0.08                   | 0.94                                      | 5.77                                      |
| 22-032-WR-2 | 0.36              | 11.2                                 | 8.54                          | -2.7                                      | 0.2                    | 0.03                   | 0.13                   | 0.94                                      | 7.61                                      |

**LEGEND**

SE1 - Upgradient on Cataract Creek.  
SE2 - Downgradient on Cataract Creek.  
WR1 - Composite of subsamples WR1, 2, 3, and 4.  
WR2 - Composite of WR5A and 5B.  
BACKGROUND - From the Morning Glory (22-077-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Crystal  
Legal Description: T 7N R 5W  
Mining District: Basin/Cataract  
Latitude: N 46° 21' 01"  
Longitude: W 112° 15' 37"  
Land Status: Private/Public  
Quad: Basin  
Inspectors: Babits, Lasher/Pierson  
Organization: Pioneer Technical Services,  
Inc./ Thomas, Dean and Hoskins, Inc.

County: Jefferson  
Section(s): NW 1/4, All 1/4, Sec. 20  
Mine Type: Hardrock/Au, Ag, Cu, Pb, Zn  
Primary Drainage: Cataract Creek  
USGS Code: 10020006  
Secondary Drainage: Uncle Sam Gulch  
Date Investigated: July 7, 1993  
P.A. # 22-073

- No mill tailings were observed at this site during the investigation.
- Approximately 15 acres of disturbed (strip mined) area was identified at the site. The following elements were elevated at least three times background:

|                              |                            |
|------------------------------|----------------------------|
| Arsenic: 458J to 7,310 mg/kg | Cadmium: 2.1 to 18.4 mg/kg |
| Copper: 292 to 1,250 mg/kg   | Iron: 65,100 mg/kg         |
| Mercury: 0.492J mg/kg        | Lead: 188J to 3,570 mg/kg  |
| Antimony: 23 to 73 mg/kg     | Zinc: 479 to 3,260 mg/kg   |
- One discharging adit was identified at the site. The pH measurement in the adit discharge was 3.41. MCLs for arsenic, cadmium, and copper were exceeded in the adit discharge. Acute and chronic aquatic life criteria were exceeded for arsenic, cadmium, copper, lead, and zinc.
- Waste rock was observed directly in the Uncle Sam Gulch drainage. Observed releases to Uncle Sam Gulch were documented for arsenic, cadmium, copper, iron, lead, and zinc. MCLs were exceeded for arsenic, cadmium, and copper in the downstream sample; these exceedances were directly attributable to the site. Acute and chronic aquatic life criteria were exceeded for arsenic and cadmium in the downstream sample, again attributable to the site.
- The U.S. Department of Energy was conducting a research project at this site at the time of the investigation. Settling ponds were being constructed for the treatment of Acid Mine Drainage.
- Two potentially hazardous open adits and a hazardous loadout structure were identified at the site.



**Crystal PA# 22-073**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/07/93**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 22-073-SE-1 | 434 J      | 19.3       | 8.1        | 1.8        | 1.4        | 27.4       | 4820       | 0.048 J    | 224        | 3          | 513 J      | 10         | 1110       | NR              |
| 22-073-SE-2 | 1900 J     | 49.4       | 1          | 7.7        | 2.1        | 203        | 17600      | 0.057 J    | 758        | 4          | 999 J      | 57         | 487        | NR              |
| 22-073-WR-1 | 2510 J     | 94         | 18.4       | 16.5       | 6.3        | 292        | 38100      | 0.059 J    | 1310       | 13         | 862 J      | 23         | 3260       | NR              |
| 22-073-WR-2 | 524 J      | 39.6       | 0.6 U      | 17.6       | 5.2        | 337        | 38000      | 0.062 J    | 2640       | 10         | 559 J      | 7          | 479        | NR              |
| 22-073-WR-3 | 449 J      | 59         | 17.8       | 8.4        | 1.7        | 376        | 13800      | 0.031 J    | 743        | 7          | 3570 J     | 32         | 2230       | NR              |
| 22-073-WR-4 | 3880 J     | 341        | 2.1        | 7.6        | 3.4        | 410        | 23600      | 0.062 J    | 1350       | 8          | 3350 J     | 65         | 783        | NR              |
| 22-073-WR-5 | 7310 J     | 11.4       | 0.5 U      | 1.3        | 1 U        | 1250       | 65100      | 0.492 J    | 19.7       | 2          | 3090 J     | 73         | 290        | NR              |
| 22-073-WR-6 | 458 J      | 45         | 2          | 5.4        | 2.4        | 88.5       | 10200      | 0.051 J    | 263        | 3          | 188 J      | 6          | 482        | NR              |
| 22-073-WR-7 | 390 J      | 23.5       | 0.4 U      | 1.6        | 2          | 39.7       | 5580       | 0.107 J    | 140        | 3          | 339 J      | 9          | 103        | NR              |
| 22-077-SE-3 | 539        | 57         | 13.6       | 20.2       | 2.6 J      | 848 J      | 11600      | 0.033 J    | 1020 J     | 5          | 387 JX     | 15 J       | 937 JX     | NR              |
| BACKGROUND  | 140 J      | 193        | 0.7 U      | 9.4        | 14.9       | 71.2       | 21200      | 0.114 J    | 1930       | 11         | 56 J       | 5 U        | 159        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE 1/1000t | NEUTRAL. POTENT. 1/1000t | SULFUR ACID BASE POTENT. 1/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE 1/1000t | SULFUR ACID BASE POTENT. 1/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 22-073-WR-1 | 0.61           | 19.1                           | 2.13                     | -17                              | 0.29             | 0.16             | 0.16             | 5                                | -2.87                            |
| 22-073-WR-2 | 0.01           | 0.31                           | 4.83                     | 4.52                             | 0.01             | <0.01            | <0.01            | 0                                | 4.83                             |
| 22-073-WR-3 | 0.63           | 19.7                           | 7.36                     | -12                              | <0.01            | 0.37             | 0.39             | 11.6                             | -4.2                             |
| 22-073-WR-4 | 0.25           | 7.81                           | 5.47                     | -2.3                             | 0.24             | <0.01            | 0.01             | 0                                | 5.47                             |
| 22-073-WR-5 | 3.75           | 117                            | -9.8                     | -127                             | 0.35             | 2.47             | 0.93             | 77.2                             | -87                              |
| 22-073-WR-6 | 0.01           | 0.31                           | 6.65                     | 6.34                             | <0.01            | 0.01             | <0.01            | 0.31                             | 6.34                             |
| 22-073-WR-7 | 0.08           | 2.5                            | -0.9                     | -3.4                             | <0.01            | 0.02             | 0.1              | 0.62                             | -1.51                            |

**WATER MATRIX ANALYSES**

**Metals in Water**      **Results in ug/L**

| FIELD ID    | As   | Ba   | Cd     | Co    | Cr     | Cu      | Fe       | Hg      | Mn       | Ni     | Pb      | Sb     | HARDNESS CALC. Zn (mg CaCO3/L) |
|-------------|------|------|--------|-------|--------|---------|----------|---------|----------|--------|---------|--------|--------------------------------|
| 22-073-SW-1 | 5.59 | 6.4  | 2.57 U | 9.7 U | 6.83 U | 10.8 J  | 228 J    | 0.038 U | 15.8 JX  | 12.7 U | 5.14 JX | 30.7 U | 38.4 J    9.5                  |
| 22-073-SW-2 | 724  | 10.4 | 131    | 52.7  | 8.4 J  | 3130 J  | 9340 J   | 0.038 U | 2100 JX  | 12.7 U | 46.8 JX | 30.7 U | 11500 J    46.6                |
| 22-073-SW-4 | 9910 | 29.8 | 1010   | 363   | 12.5 J | 26700 J | 112000 J | 0.038 U | 13600 JX | 59.1   | 425 JX  | 172    | 84300 J    224                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Wet Chemistry**

**Results in mg/l**

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 22-073-SW-1 | 46                     | < 5.0    | < 10    | < 0.05    | NR      |
| 22-073-SW-2 | 191                    | < 5.0    | 97      | < 0.05    | NR      |
| 22-073-SW-4 | 1230                   | < 5.0    | 710     | < 0.05    | NR      |

**LEGEND**

SE1 - Approx. 300' upgradient on Uncle Sam Gulch  
SE2 - Downgradient of adit discharge PPE in Uncle Sam Gulch.  
22-077-SE3 - Uncle Sam Gulch; prior to discharge.  
WR1 - Composite of subsamples WR1A and 1B.  
WR2 - Composite of subsamples WR1C and 1D.  
WR3 - Composite of subsamples WR2A, 2B, 2C, and 2D.  
WR4 - Composite of subsamples WR3A, 3B, 3C, 3E, and 3F.  
WR5 - Sample of subsample WR4A.  
WR6 - Composite of subsamples WR4B, 4C, 4D, and 4E.  
WR7 - Composite of subsamples WR4F and 4G.  
BACKGROUND - From Crystal Mine.  
(22-073-SS-1).  
SW1 - Same as SE1.  
SW2 - Same as SE2.  
SW4 - Adit discharge.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Eva May</u>                        | County: <u>Jefferson</u>                   |
| Legal Description: T <u>7N</u> R <u>5W</u>            | Section(s): <u>NW 1/4, NW 1/4, Sec. 22</u> |
| Mining District: <u>Cataract</u>                      | Mine Type: <u>Hardrock/Pb, Cu, Au, Ag</u>  |
| Latitude: <u>N 46° 21' 00"</u>                        | Primary Drainage: <u>Cataract Creek</u>    |
| Longitude: <u>W 112° 13' 20"</u>                      | USGS Code: <u>10020006</u>                 |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Cataract Creek</u>  |
| Quad: <u>Mount Thompson</u>                           | Date Investigated: <u>July 7, 1993</u>     |
| Inspectors: <u>Bullock, Belanger, Clark</u>           | P.A. # <u>22-075</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- The volume of tailings associated with this site was estimated to be approximately 11,000 cubic yards. The following elements were elevated at least three times background:

|                     |                    |
|---------------------|--------------------|
| Arsenic: 1300 mg/kg | Cadmium: 2.8 mg/kg |
| Lead: 1450JX mg/kg  | Antimony: 70 mg/kg |
- The tailings may erode into Cataract Creek during storm events.
- The volume of waste rock associated with this site was estimated to be approximately 92,000 cubic yards. The following elements were elevated at least three times background:

|                              |                                 |
|------------------------------|---------------------------------|
| Arsenic: 14,700 mg/kg        | Cadmium: 11.2 mg/kg             |
| Copper: 357J mg/kg           | Mercury: 0.199J to 0.585J mg/kg |
| Lead: 1270JX to 5970JX mg/kg | Antimony: 114J to 165J mg/kg    |
| Zinc: 1660JX mg/kg           |                                 |
- The adit discharge at Adit #2 exceeded the MCL for arsenic and the MCL/MCLG for Cadmium. Acute aquatic life criteria was exceeded for iron, copper, and zinc. Chronic aquatic life criteria was exceeded for cadmium, copper, lead and zinc. The adit discharge had a low flow rate of approximately 5 gpm and had a pH of 6.67 and a specific conductance of 355 umhos/cm. The discharge entered a small diversion ditch from Cataract Creek which flowed through WR-2 then returned to the Creek.
- Water samples from Cataract Creek were not collected during this investigation due to high relative flows. Sediment samples collected from Cataract Creek documented observed releases of arsenic, copper, lead, and antimony.

**Eva May PA# 22-075**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/07/93**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 22-075-SE-1 | 49         | 33.9       | 0.8        | 2.1        | 3.2 J      | 30.2 J     | 5940       | 0.036 J    | 291 J      | 3          | 87 JX      | 11 J       | 174 JX     | NR              |
| 22-075-SE-2 | 8          | 25.3       | 0.6 U      | 3          | 4.2 J      | 9.4 J      | 5870       | 0.022 J    | 240 J      | 3 U        | 14 JX      | 7 UJ       | 75 JX      | NR              |
| 22-075-TP-1 | 1300       | 170        | 2.8        | 3          | 4.7 J      | 206 J      | 22300      | 0.082 J    | 160 J      | 4          | 1450 JX    | 70 J       | 420 JX     | NR              |
| 22-075-WR-1 | 384        | 31.6       | 0.7        | 7.9        | 1.2 UJ     | 357 J      | 29900      | 0.585 J    | 102 J      | 2 U        | 1270 JX    | 165 J      | 60 JX      | NR              |
| 22-075-WR-2 | 14700      | 4.2        | 11.2       | 1.5 U      | 1 UJ       | 56.5 J     | 14200      | 0.199 J    | 9.4 J      | 2 U        | 5970 JX    | 114 J      | 1660 JX    | NR              |
| BACKGROUND  | 140 J      | 193        | 0.7 U      | 9.4        | 14.9       | 71.2       | 21200      | 0.114 J    | 1930       | 11         | 56 J       | 5 U        | 159        | < 1.227         |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID       | TOTAL SULFUR % | TOTAL SULFUR ACID BASE $\mu/1000t$ | NEUTRAL. POTENT. $\mu/1000t$ | SULFUR ACID BASE POTENT. $\mu/1000t$ | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE $\mu/1000t$ | SULFUR ACID BASE POTENT. $\mu/1000t$ |
|----------------|----------------|------------------------------------|------------------------------|--------------------------------------|------------------|------------------|------------------|--------------------------------------|--------------------------------------|
| 22-075-TP-1    | 0.23           | 7.19                               | -0.2                         | -7.4                                 | 0.2              | 0.01             | 0.02             | 0.31                                 | -0.52                                |
| 22-075-WR-1DUP | 2.63           | 82.2                               | -3                           | -85                                  | 2.49             | <0.01            | 0.15             | 0                                    | -3.02                                |
| 22-075-WR-1    | 2.63           | 82.2                               | -3.5                         | -86                                  | 2.49             | <0.01            | 0.14             | 0                                    | -3.52                                |
| 22-075-WR-2DUP | 2.59           | 80.9                               | -3.7                         | -85                                  | 0.61             | 1.15             | 0.83             | 35.9                                 | -39.6                                |
| 22-075-WR-2    | 2.58           | 80.6                               | -3.9                         | -85                                  | 0.57             | 1.18             | 0.83             | 36.9                                 | -40.8                                |

**Cation/Exchange Capacity**

| FIELD ID    | milliequivalents/100g |
|-------------|-----------------------|
| 22-075-TP-1 | 6.17                  |

**Mechanical Analysis and % Coarse Material**

| FIELD ID    | % CLAY | % SAND | % SILT | % COARSE MATERIAL (>2mm) |
|-------------|--------|--------|--------|--------------------------|
| 22-075-TP-1 | 2      | 82     | 16     | 0                        |

**WATER MATRIX ANALYSES**

**Metals in Water**  
**Results in ug/L**

| FIELD ID    | As     | Ba  | Cd   | Co    | Cr     | Cu     | Fe   | Hg      | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO <sub>3</sub> /L) | HARDNESS CALC. |
|-------------|--------|-----|------|-------|--------|--------|------|---------|------|--------|--------|--------|------------------------------|----------------|
| 22-075-GW-1 | 65.9 J | 132 | 5.93 | 9.7 U | 6.83 U | 67.2 J | 1750 | 0.230 J | 1300 | 12.7 U | 11.7 J | 30.7 U | 1490                         | 178            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Wet Chemistry**  
**Results in mg/l**

| FIELD I.D.  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO <sub>3</sub> /NO <sub>2</sub> -N | CYANIDE |
|-------------|------------------------|----------|---------|-------------------------------------|---------|
| 22-075-GW-1 | 260                    | < 5.0    | 72      | < 0.05                              | NR      |

**LEGEND**

SE1 - Downstream Cataract Creek.  
 SE2 - Upstream Cataract Creek.  
 TP1 - Composite of subsample TP1A, 1B, 1C, and 1D-A.  
 WR1 - Composite of subsamples WR1B and 1C.  
 WR2 - Sample of the WR2A subsample.  
 BACKGROUND - From the Crystal Mine (22-073-SS-1).  
 WR1DUP - Duplicate of the 22-075-WR-1 sample.

WR2DUP - Duplicate of the 22-075-WR-2 sample.  
 GW1 - Discharge from adit #2.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Morning Glory</u>                  | County: <u>Jefferson</u>                  |
| Legal Description: T <u>7N</u> R <u>5W</u>            | Section(s): <u>E 1/4, NW 1/4, Sec. 33</u> |
| Mining District: <u>Cataract</u>                      | Mine Type: <u>Hardrock/Ag, Pb, Au, Zn</u> |
| Latitude: <u>N 46° 19' 05"</u>                        | Primary Drainage: <u>Boulder River</u>    |
| Longitude: <u>W 112° 14' 35"</u>                      | USGS Code: <u>10020006</u>                |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Cataract Creek</u> |
| Quad: <u>Mount Thompson</u>                           | Date Investigated: <u>July 7, 1993</u>    |
| Inspectors: <u>Bullock, Belanger, Clark</u>           | P.A. # <u>22-077</u>                      |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- The volume of tailings associated with this site was estimated to be approximately 7200 cubic yards. The following elements were elevated at least three times background:

|                                   |                                 |
|-----------------------------------|---------------------------------|
| Arsenic: 91 to 2250 mg/kg         | Cadmium: 4.8 to 7.8 mg/kg       |
| Copper: 97.3J to 150J mg/kg       | Mercury: 0.188J to 0.248J mg/kg |
| Manganese: 5190J to 22,800J mg/kg | Nickel: 25 mg/kg                |
| Lead: 475JX to 2070JX mg/kg       | Zinc: 1140JX to 1210JX mg/kg    |
- The tailings oxidized zone, ranging 2 to 4 feet deep, contained significantly higher concentrations of arsenic and lead than the underlying reduced zone.
- The volume of waste rock associated with this site was estimated to be approximately 29,000 cubic yards. The following elements were elevated at least three times background:

|                      |                        |
|----------------------|------------------------|
| Arsenic: 48 mg/kg    | Cadmium: 1.5 mg/kg     |
| Cobalt: 11.9 mg/kg   | Copper: 33.6J mg/kg    |
| Mercury: 0.54J mg/kg | Manganese: 3830J mg/kg |
| Lead: 88JX mg/kg     |                        |
- There were no adit discharges, seeps or springs associated with this site.
- Cataract Creek flowed along the base of the waste rock dumps and tailings impoundment. No surface water samples were collected due to the high dilution effect from the creek. Sediment samples were collected up and down stream of the site, as well as in Uncle Sam Creek, just above its confluence with Cataract Creek. The down stream sample (SE-2) showed significant increases in arsenic, cadmium, cobalt, copper, lead, and zinc concentrations, but due to the very high concentrations found in the Uncle Sam Creek Sample (SE-3), no observed release could be directly attributed to this site. The Crystal Mine was situated on the headwaters of Uncle Sam Creek and was probably the source of contaminants found in SE-3



**Morning Glory PA# 22-077**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/07/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 22-077-SE-1 | 9             | 19.6          | 0.6 U         | 2.5           | 1.6 UJ        | 19.3 J        | 3450          | 0.012 U       | 284 J         | 3 U           | 33 JX         | 7 UJ          | 135 JX        | NR                 |
| 22-077-SE-2 | 93            | 19.1          | 4.1           | 10.6          | 1.7 J         | 170 J         | 4960          | 0.01 U        | 617 J         | 2 U           | 91 JX         | 6 UJ          | 243 JX        | NR                 |
| 22-077-SE-3 | 539           | 57            | 13.6          | 20.2          | 2.6 J         | 848 J         | 11600         | 0.033 J       | 1020 J        | 5             | 387 JX        | 15 J          | 937 JX        | NR                 |
| 22-077-TP-1 | 2250          | 65.4          | 7.8           | 3.1           | 5.5 J         | 150 J         | 17400         | 0.248 J       | 5190 J        | 7             | 2070 JX       | 66 J          | 1140 JX       | NR                 |
| 22-077-TP-2 | 91            | 26.4          | 4.8           | 2.4           | 7.2 J         | 97.3 J        | 12900         | 0.188 J       | 22800 J       | 25            | 475 JX        | 6 J           | 1210 JX       | NR                 |
| 22-077-WR-1 | 48            | 22.1          | 1.5           | 11.9          | 7.8 J         | 33.6 J        | 19900         | 0.54 J        | 3830 J        | 12            | 88 JX         | 6 UJ          | 185 JX        | NR                 |
| BACKGROUND  | 15            | 65.1          | 0.5 U         | 4             | 6.3 J         | 10.3 J        | 9160          | 0.01 J        | 344 J         | 6             | 11 JX         | 7 UJ          | 94 JX         | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|----------------------|---|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 22-077-SS-1 | 0.01                 | 0.31                                    | 1.92                          | 1.61                                      | 0.01                   | <0.01                  | <0.01                  | 0   | 1.92                                      |
| 22-077-TP-1 | 0.19                 | 5.94                                    | 74.6                          | 68.7                                      | 0.08                   | 0.08                   | 0.03                   | 2.5                                       | 72.1                                      |
| 22-077-TP-2 | 0.27                 | 8.43                                    | 128                           | 120                                       | 0.02                   | 0.2                    | 0.05                   | 6.25                                      | 122                                       |
| 22-077-WR-1 | 0.73                 | 22.8                                    | 73.3                          | 50.5                                      | 0.12                   | 0.47                   | 0.14                   | 14.7                                      | 58.6                                      |

**LEGEND**

SE1 - Cataract Creek upgradient.  
SE2 - Cataract Creek downgradient.  
SE3 - Uncle Sam Creek at confluence with Cataract Creek.  
TP1 - Composite of subsamples TP1A-A and 1B-A.  
TP2 - Composite of subsamples TP1A-B, 1A-C, 1B-B, and 1B-C.  
WR1 - Composite of subsamples WR1A, 1B, 1C, 2A, and 2B.  
BACKGROUND - From the Morning Glory Mine (22-077-SS-1).  
SS1 - Same as the BACKGROUND sample.

Minah Mines, were inaccessible and no data was collected. The Mother Lode site was not ranked because it was actually a photographic film recycling facility. The final unranked investigation was actually a comprehensive sampling of a drainage basin and the individual sites within the basin were ranked separately.

The AIMSS also generates a distinct safety score for each site by evaluating site accessibility and safety hazards present (i.e., shafts, stopes, open adits, hazardous structures, and explosives/other hazardous materials or chemicals). Table 4-2 lists the priority sites and their associated safety score, sorted in descending order.

This ranking should be considered dynamic and will change as sites are added and/or removed from the priority list. Additional sites will be added to the priority list as they are identified. Sites will be removed from the priority list following successful completion of reclamation activities.

| SITE RANK | SITE NAME               | COUNTY        | PA No. | SAFETY SCORE |
|-----------|-------------------------|---------------|--------|--------------|
| 1         | Franklin                | Lewis & Clark | 25-339 | 30060.00     |
| 2         | Trout                   | Granite       | 20-062 | 4819.50      |
| 3         | Marcelline              | Judith Basin  | 23-022 | 377.40       |
| 4         | Algonquin               | Granite       | 20-005 | 344.00       |
| 5         | Strawberry              | Madison       | 29-038 | 272.40       |
| 6         | Rochester               | Cascade       | 07-110 | 262.50       |
| 7         | Compromise              | Cascade       | 07-100 | 261.00       |
| 8         | Molton                  | Cascade       | 07-084 | 250.00       |
| 9         | True Fissure            | Granite       | 20-111 | 255.00       |
| 10        | Block P Mine            | Judith Basin  | 23-001 | 246.40       |
| 11        | Morning Glory           | Jefferson     | 22-077 | 198.40       |
| 12        | Evening Star Millsite   | Cascade       | 07-087 | 186.00       |
| 13        | Park (Marietta)         | Broadwater    | 04-012 | 184.00       |
| 14        | Alhambra Hot Springs    | Jefferson     | 22-049 | 180.00       |
| 15        | Buckeyes                | Madison       | 29-451 | 175.00       |
| 16        | Comet Tailings          | Jefferson     | 22-008 | 173.78       |
| 17        | Corbin Flats            | Jefferson     | 22-004 | 172.50       |
| 18        | Red Water               | Lewis & Clark | 25-007 | 165.00       |
| 19        | Diamond Hill            | Broadwater    | 04-020 | 161.25       |
| 20        | Dacotah                 | Cascade       | 07-121 | 147.00       |
| 21        | Bald Mountain           | Lewis & Clark | 25-091 | 128.00       |
| 22        | Curlew                  | Ravalli       | 41-003 | 122.10       |
| 23        | Alta                    | Jefferson     | 22-001 | 116.80       |
| 24        | Banner                  | Granite       | 20-175 | 103.50       |
| 25        | Mammoth Tailings        | Madison       | 29-082 | 101.25       |
| 26        | Lower Letterman         | Sanders       | 45-047 | 100.00       |
| 27        | Silver Bell             | Cascade       | 07-111 | 98.00        |
| 28        | Victory/Evening Star    | Lewis & Clark | 25-010 | 91.00        |
| 29        | Vilpa                   | Cascade       | 07-080 | 85.80        |
| 30        | Wateca Millsite         | Madison       | 29-075 | 75.40        |
| 31        | NE NW S13               | Lewis & Clark | 25-197 | 75.00        |
| 32        | Indian Queen            | Beaverhead    | 01-034 | 75.00        |
| 33        | Old Dominion            | Granite       | 20-180 | 72.00        |
| 34        | Yager/Daisy             | Sweet Grass   | 49-002 | 71.00        |
| 35        | Cumberland              | Meagher       | 30-004 | 63.00        |
| 36        | Broadway/Victoria       | Madison       | 29-178 | 62.75        |
| 37        | Silver Lake Millsite    | Deer Lodge    | 12-070 | 62.00        |
| 38        | Atlantis                | Cascade       | 07-113 | 60.00        |
| 39        | Lucky Strike/NE NE S7   | Judith Basin  | 23-042 | 56.00        |
| 40        | Lower Glengarry         | Park          | 34-006 | 56.00        |
| 41        | Montro Gold             | Sanders       | 45-010 | 55.00        |
| 42        | Boss Tweed              | Madison       | 29-034 | 51.50        |
| 43        | Lady Luck               | Lewis & Clark | 25-073 | 50.00        |
| 44        | Blue Bird               | Ravalli       | 41-009 | 48.13        |
| 45        | Ohio                    | Broadwater    | 04-009 | 47.00        |
| 46        | Ermont Mill & Mines     | Beaverhead    | 01-005 | 45.00        |
| 47        | Silver Dyke Tailings    | Cascade       | 07-137 | 45.00        |
| 48        | Douglas Creek Tailings  | Granite       | 20-003 | 44.00        |
| 49        | Grey Eagle              | Jefferson     | 22-029 | 44.00        |
| 50        | Scratch All             | Granite       | 20-019 | 42.90        |
| 51        | Bullion                 | Jefferson     | 22-008 | 42.50        |
| 52        | Belmont                 | Lewis & Clark | 25-167 | 42.00        |
| 53        | Golden Anchor           | Powell        | 39-012 | 41.80        |
| 54        | Homestake No. 2         | Park          | 34-093 | 41.00        |
| 55        | Sourdough               | Jefferson     | 22-336 | 40.50        |
| 56        | Brooklyn                | Granite       | 20-025 | 40.50        |
| 57        | Armstrong               | Lewis & Clark | 25-102 | 40.00        |
| 58        | Mammoth                 | Madison       | 29-008 | 40.00        |
| 59        | Rising Sun              | Silver Bow    | 47-037 | 40.00        |
| 60        | Lower Cleve             | Beaverhead    | 01-143 | 39.00        |
| 61        | Forest Rose             | Granite       | 20-004 | 37.20        |
| 62        | Empire Millsite         | Lewis & Clark | 25-175 | 36.40        |
| 63        | SE NW S24               | Meagher       | 30-017 | 36.00        |
| 64        | Silver Dyke Millsite    | Cascade       | 07-138 | 35.20        |
| 65        | Tungsten Millsite       | Beaverhead    | 01-170 | 35.00        |
| 66        | Cumberland              | Fergus        | 14-017 | 35.00        |
| 67        | Nancy Lee Mill - Slowey | Mineral       | 31-080 | 33.80        |
| 68        | East Pacific            | Broadwater    | 04-008 | 33.55        |

| SITE RANK | SITE NAME               | COUNTY        | PA No. | SAFETY SCORE |
|-----------|-------------------------|---------------|--------|--------------|
| 69        | Broad Gauge             | Madison       | 29-293 | 33.00        |
| 70        | Wickes Smelter          | Jefferson     | 22-358 | 32.00        |
| 71        | Washington              | Jefferson     | 22-007 | 31.20        |
| 72        | Monarch                 | Powell        | 39-008 | 30.25        |
| 73        | Kearsage                | Madison       | 29-102 | 30.00        |
| 74        | Maud S.                 | Cascade       | 07-120 | 30.00        |
| 75        | Mary Emma/Clinton       | Silver Bow    | 47-035 | 30.00        |
| 76        | Lucky Joe               | Ravalli       | 41-027 | 29.75        |
| 77        | SW NE S10               | Meagher       | 30-078 | 28.05        |
| 78        | Champion                | Deer Lodge    | 12-003 | 28.00        |
| 79        | Gold Dust               | Park          | 34-007 | 28.00        |
| 80        | Red Mtn. - North & #13  | Lewis & Clark | 25-019 | 28.00        |
| 81        | Thistle No. 1           | Madison       | 29-073 | 28.00        |
| 82        | Karst Asbestos          | Gallatin      | 16-018 | 27.00        |
| 83        | Big Ox Millsite         | Lewis & Clark | 25-115 | 26.40        |
| 84        | Argo                    | Broadwater    | 04-015 | 26.00        |
| 85        | Silver Dike Adit        | Cascade       | 07-135 | 25.50        |
| 86        | Spring Hill Tailings    | Lewis & Clark | 25-067 | 25.00        |
| 87        | Martin                  | Beaverhead    | 01-270 | 24.00        |
| 88        | Termite Mine            | Lewis & Clark | 25-005 | 23.80        |
| 89        | Nonpareil               | Granite       | 20-012 | 23.50        |
| 90        | Swansea Tailings        | Lewis & Clark | 25-208 | 23.10        |
| 91        | Gold Leaf/Priscilla     | Beaverhead    | 01-031 | 23.00        |
| 92        | Beatrice                | Lewis & Clark | 25-103 | 22.80        |
| 93        | Goldschmidt-Steiner     | Madison       | 29-078 | 22.40        |
| 94        | Nellie Grant            | Jefferson     | 22-244 | 21.80        |
| 95        | Granite Mountain        | Granite       | 20-110 | 21.50        |
| 96        | Boaz                    | Madison       | 29-013 | 21.00        |
| 97        | Tacoma                  | Jefferson     | 22-284 | 21.00        |
| 98        | Gold Coin Mine          | Deer Lodge    | 12-004 | 20.90        |
| 99        | Eva May                 | Jefferson     | 22-075 | 20.80        |
| 100       | Bigler                  | Meagher       | 30-067 | 20.40        |
| 101       | Davis Gulch II          | Lewis & Clark | 25-040 | 20.00        |
| 102       | Mitchell Creek          | Lincoln       | 27-055 | 20.00        |
| 103       | Emery                   | Powell        | 39-004 | 20.00        |
| 104       | Thompson Mica           | Gallatin      | 16-015 | 20.00        |
| 105       | Grubstake               | Madison       | 29-399 | 20.00        |
| 106       | Dry Gulch (South)       | Madison       | 29-282 | 19.00        |
| 107       | Miller Mountain         | Broadwater    | 04-138 | 19.00        |
| 108       | Upper Valley Forge      | Lewis & Clark | 25-280 | 18.70        |
| 109       | NE NW S32               | Powell        | 39-052 | 17.50        |
| 110       | Maxville Tailings       | Granite       | 20-209 | 16.80        |
| 111       | McLaren Mine            | Park          | 34-010 | 16.50        |
| 112       | Silver King             | Granite       | 20-186 | 15.60        |
| 113       | Upper Alice E.          | Park          | 34-085 | 15.00        |
| 114       | Sherman No. 2 - SW      | Cascade       | 07-142 | 14.40        |
| 115       | Argentine               | Jefferson     | 22-102 | 14.00        |
| 116       | Lily/Orphan Boy         | Powell        | 39-006 | 14.00        |
| 117       | Linton                  | Missoula      | 32-017 | 13.60        |
| 118       | Old Eldhorn             | Beaverhead    | 01-169 | 13.00        |
| 119       | Barbow Millsite         | Silverwater   | 48-005 | 12.50        |
| 120       | Eldhorn Queen           | Jefferson     | 22-027 | 12.20        |
| 121       | Baker                   | Cascade       | 07-190 | 12.00        |
| 122       | Blackfoot Tailings      | Lewis & Clark | 25-322 | 12.00        |
| 123       | Upper Triangler         | Missoula      | 32-048 | 12.00        |
| 124       | Atlantic & Pacific      | Madison       | 29-033 | 11.40        |
| 125       | Missouri                | Madison       | 29-373 | 11.25        |
| 126       | Smuggler                | Madison       | 29-010 | 11.00        |
| 127       | Rumsey Mine/Millsite    | Granite       | 20-018 | 10.80        |
| 128       | Porcupine               | Meagher       | 30-069 | 10.60        |
| 129       | Middle Fk. Warm Springs | Jefferson     | 22-046 | 10.20        |
| 130       | Highland Mine           | Silver Bow    | 47-028 | 10.00        |
| 131       | Edwards Lode            | Judith Basin  | 23-046 | 10.00        |
| 132       | Apex Millsite           | Beaverhead    | 01-008 | 9.90         |
| 133       | Sure Thing              | Powell        | 39-020 | 9.00         |
| 134       | SE SW S28 (Keynote)     | Madison       | 29-474 | 9.00         |
| 135       | St. Louis               | Broadwater    | 04-013 | 8.95         |
| 136       | Kimball                 | Powell        | 39-018 | 8.60         |

| SITE RANK | SITE NAME               | COUNTY        | PA No. | SAFETY SCORE |
|-----------|-------------------------|---------------|--------|--------------|
| 137       | Seven-Up Pete/Rover     | Lewis & Clark | 25-020 | 8.70         |
| 138       | Hopkins                 | Mineral       | 31-078 | 8.40         |
| 139       | Bald Butte Millsite     | Lewis & Clark | 25-179 | 8.00         |
| 140       | Nugget                  | Missoula      | 32-042 | 8.00         |
| 141       | Hard Luck               | Powell        | 39-014 | 7.60         |
| 142       | Tail Hook               | Fergus        | 14-010 | 7.60         |
| 143       | Charter Oak             | Powell        | 39-003 | 7.50         |
| 144       | Joe Waller              | Missoula      | 32-010 | 7.50         |
| 145       | Alps                    | Granite       | 20-085 | 7.20         |
| 146       | Pooman/Emma             | Sweet Grass   | 49-001 | 7.20         |
| 147       | Mouat Mine              | Silverwater   | 48-001 | 6.05         |
| 148       | Keystone                | Mineral       | 31-074 | 6.00         |
| 149       | Fisher Creek No. 1      | Park          | 34-080 | 6.00         |
| 150       | Sherman No. 2 - NE      | Cascade       | 07-140 | 6.00         |
| 151       | Snowshoe                | Lincoln       | 27-005 | 6.00         |
| 152       | Goldsil Millsite        | Lewis & Clark | 25-385 | 5.70         |
| 153       | Apex                    | Madison       | 29-105 | 5.00         |
| 154       | Dee Creek               | Sanders       | 45-041 | 5.00         |
| 155       | Piegan/Gloster Millsite | Lewis & Clark | 25-172 | 4.80         |
| 156       | Norwegian               | Madison       | 29-006 | 4.80         |
| 157       | Stallabass              | Cascade       | 07-140 | 4.50         |
| 158       | Pacific                 | Madison       | 29-110 | 4.50         |
| 159       | Maiden Rock             | Silver Bow    | 47-051 | 4.20         |
| 160       | Elk Creek Corundum      | Gallatin      | 16-013 | 4.20         |
| 161       | Harrison/Moulton        | Judith Basin  | 23-058 | 3.80         |
| 162       | Anna R./Hattie M.       | Powell        | 39-044 | 3.60         |
| 163       | Lost Cabin              | Missoula      | 32-011 | 3.20         |
| 164       | Telegraph Mine          | Powell        | 39-023 | 3.10         |
| 165       | Montana Prince          | Ravalli       | 41-004 | 3.00         |
| 166       | Morse & Kennedy         | Missoula      | 32-033 | 3.00         |
| 167       | Red Pine                | Madison       | 29-078 | 2.80         |
| 168       | JTC                     | Madison       | 29-106 | 2.50         |
| 169       | Wasa                    | Granite       | 20-023 | 2.50         |
| 170       | Argo Millsite           | Lewis & Clark | 25-314 | 2.40         |
| 171       | Haulita                 | Missoula      | 32-057 | 2.40         |
| 172       | Marguerite              | Jefferson     | 22-301 | 2.00         |
| 173       | Mountain View           | Powell        | 39-062 | 2.00         |
| 174       | Jack Waite              | Sanders       | 45-002 | 2.00         |
| 175       | Trapper                 | Beaverhead    | 01-144 | 1.60         |
| 176       | Middle Fork Millsite    | Silver Bow    | 47-081 | 1.60         |
| 177       | Ward Lode               | Missoula      | 32-005 | 1.50         |
| 178       | Julia                   | Powell        | 39-022 | 1.30         |
| 179       | Viking                  | Lewis & Clark | 29-077 | 1.25         |
| 180       | Pangewasset             | Lewis & Clark | 25-226 | 1.25         |
| 181       | Belle Of the Castle     | Meagher       | 30-007 | 1.00         |
| 182       | Bon Ton                 | Cascade       | 07-094 | 0.80         |
| 183       | Astor                   | Lewis & Clark | 25-227 | 0.80         |
| 184       | Tiger                   | Judith Basin  | 23-059 | 0.75         |
| 185       | Bertha                  | Jefferson     | 22-002 | 0.60         |
| 186       | Nancy Lee Mine          | Mineral       | 31-001 | 0.50         |
| 187       | Mill Creek Mine         | Missoula      | 32-049 | 0.50         |
| 188       | Solar Silver            | Jefferson     | 22-054 | 0.50         |
| 189       | Moulton                 | Judith Basin  | 23-058 | 0.45         |
| 190       | Garrett Hill            | Beaverhead    | 01-092 | 0.00         |
| 191       | NW SE S22               | Sweet Grass   | 49-003 | 0.00         |
| 192       | Last Chance No. 2       | Beaverhead    | 01-220 | 0.00         |
| 193       | Nancy Lee Millsite      | Mineral       | 31-082 | 0.00         |
| 194       | SE SE S13               | Lewis & Clark | 25-294 | 0.00         |
| 195       | Mother Lode             | Lewis & Clark | 25-363 | 0.00         |
| 196       | Vortex                  | Judith Basin  | 23-027 | 0.00         |
| 197       | Carpenter Ck. Tailings  | Cascade       | 07-103 | 0.00         |
| 198       | Last Chance No. 1       | Beaverhead    | 01-218 | 0.00         |
| 199       | Lori No. 13             | Granite       | 20-191 | 0.00         |
| 200       | South Frying Pan        | Beaverhead    | 01-211 | 0.00         |
| 201       | Cable                   | Deer Lodge    | 12-002 | 0.00         |
| 202       | Cajon Queen No. 1       | Mineral       | 31-048 | 0.00         |
| 203       | Perry Park              | Jefferson     | 22-039 | 0.00         |
| 204       | Gold King               | Mineral       | 31-097 | 0.00         |

| SITE RANK | SITE NAME              | COUNTY        | PA No. | SAFETY SCORE |
|-----------|------------------------|---------------|--------|--------------|
| 205       | Pete & Joe             | Madison       | 29-448 | 0.00         |
| 206       | Eleanor East           | Madison       | 29-285 | 0.00         |
| 207       | Lane                   | Meagher       | 30-019 | 0.00         |
| 208       | Silver Cable           | Lincoln       | 27-068 | 0.00         |
| 209       | Bluebird               | Jefferson     | 22-003 | 0.00         |
| 210       | Valley Forge/Susie     | Lewis & Clark | 25-008 | 0.00         |
| 211       | Wright Lode            | Judith Basin  | 23-045 | 0.00         |
| 212       | Pedro                  | Madison       | 29-455 | 0.00         |
| 213       | Nelhart Tailings       | Cascade       | 07-134 | 0.00         |
| 214       | Gregory                | Jefferson     | 22-005 | 0.00         |
| 215       | Ohio                   | Madison       | 29-473 | 0.00         |
| 216       | Bl-Metallic/Old Red    | Granite       | 20-002 | 0.00         |
| 217       | Buckeye                | Jefferson     | 22-072 | 0.00         |
| 218       | NE NE S31              | Judith Basin  | 23-079 | 0.00         |
| 219       | Broken Hill            | Sanders       | 45-005 | 0.00         |
| 220       | General Shaft          | Madison       | 29-103 | 0.00         |
| 221       | Hunnebird              | Broadwater    | 04-144 | 0.00         |
| 222       | Crystal                | Jefferson     | 22-073 | 0.00         |
| 223       | Vosburg                | Broadwater    | 04-014 | 0.00         |
| 224       | Fairplay               | Cascade       | 07-112 | 0.00         |
| 225       | B&H                    | Madison       | 29-083 | 0.00         |
| 226       | Uncle Sam              | Madison       | 29-383 | 0.00         |
| 227       | Tarbox-Mineral King    | Mineral       | 31-003 | 0.00         |
| 228       | Little Daisy           | Park          | 34-008 | 0.00         |
| 229       | Basin Millsite         | Jefferson     | 22-038 | 0.00         |
| 230       | Flathead Mine          | Flathead      | 15-012 | 0.00         |
| 231       | Wildcat                | Lewis & Clark | 25-317 | 0.00         |
| 232       | General Grant          | Jefferson     | 22-245 | 0.00         |
| 233       | Lower Termite Millsite | Lewis & Clark | 25-030 | 0.00         |
| 234       | Allison                | Park          | 34-018 | 0.00         |
| 235       | Belle of the Hills     | Mineral       | 31-072 | 0.00         |
| 236       | Enterprise             | Jefferson     | 22-074 | 0.00         |
| 237       | NE SE S26              | Madison       | 29-478 | 0.00         |
| 238       | Latest Out             | Madison       | 29-354 | 0.00         |
| 239       | Belt Patent            | Judith Basin  | 23-035 | 0.00         |
| 240       | Jack Creek Tailings    | Jefferson     | 22-298 | 0.00         |
| 241       | Easton                 | Madison       | 29-121 | 0.00         |
| 242       | Emma                   | Madison       | 29-061 | 0.00         |
| 243       | Little Anaconda        | Mineral       | 31-077 | 0.00         |
| 244       | Iron Mountain Millsite | Mineral       | 31-010 | 0.00         |
| 245       | Jackson Park           | Granite       | 20-027 | 0.00         |
| 246       | Block P Tailings       | Cascade       | 07-090 | 0.00         |
| 247       | Old Glory              | Silver Bow    | 47-027 | 0.00         |
| 248       | Ontario Millsite       | Powell        | 39-010 | 0.00         |
| 249       | Big Ox Mine            | Lewis &       |        |              |



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Nellie Grant  
Legal Description: T 8N R 5W  
Mining District: Clancy  
Latitude: N 46° 26' 16"  
Longitude: W 112° 12' 07"  
Land Status: Private/Public  
Quad: Chessman Reservoir  
Inspectors: Bullock, Tuesday, Babits, Lasher,  
Clark, Belanger, Flammang/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Jefferson  
Section(s): SW 1/4, SW 1/4, Sec. 14  
Mine Type: Hardrock/Au, Ag, Cu, Pb, Zn  
Primary Drainage: Lump Gulch  
USGS Code: 10030101  
Secondary Drainage: Lump Gulch  
Date Investigated: May 18 and 19, 1993  
P.A. # 22-244

- There were approximately 10,000 cubic yards of uncovered tailings on site. The following elements were elevated at least three times background:

|                                 |                               |
|---------------------------------|-------------------------------|
| Arsenic: 4,210 to 9,500 mg/kg   | Cadmium: 10.8 to 312 mg/kg    |
| Cobalt: 27 to 28.8 mg/kg        | Chromium: 19.7J to 26J mg/kg  |
| Copper: 50.5 to 467 mg/kg       | Iron: 29, 500 to 61,400 mg/kg |
| Mercury: 0.106J to 0.235J mg/kg | Nickel: 36.6 to 37.3 mg/kg    |
| Lead: 9,380 to 13,500 mg/kg     | Zinc: 763 to 33,700 mg/kg     |
- There were approximately 2,500 cubic yards of uncovered waste rock on site. The following elements were elevated at least three times background:

|                             |                                 |
|-----------------------------|---------------------------------|
| Arsenic: 969 to 2,570 mg/kg | Cadmium: 7.6 to 9.2 mg/kg       |
| Cobalt: 10.8 mg/kg          | Copper: 87.2 to 143 mg/kg       |
| Iron: 33.600 mg/kg          | Mercury: 0.156J to 0.184J mg/kg |
| Lead: 7,410 to 15,500 mg/kg | Zinc: 417 to 934 mg/kg          |
- There were no discharging adits on site. There were three shafts that did not discharge; but, held water. Shaft #3 was sampled as GW-3 and pH 3.51 and a specific conductance of 640 umhos/cm. Arsenic and cadmium exceeded MCL/MCLGs. There were two monitoring wells on site that were potentially downgradient (GW-3 and 4) and one spring (GW-1) that was upgradient. There were observed releases of arsenic, cadmium, cobalt, copper, iron, nickel, lead, and zinc in GW-3 and cadmium and zinc in GW-4. The MCL/MCLGs were exceeded for cadmium in GW-3 and 4 and the MCL was exceeded for arsenic in GW-3.
- Lump Gulch Creek ran through eroded tailings. There were observed releases of cadmium and zinc in downstream surface water in the creek. Cadmium exceeded MCL/MCLGs in downstream surface water in the creek. The acute and chronic aquatic life criteria for copper, lead, and zinc were exceeded in downstream surface water in the creek. Elevated upgradient metal concentrations (SW-1) indicated the possible presence of an upgradient source.



**Nellie Grant Mine PA# 22-244**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER-BULLOCK**  
**INVESTIGATION DATE: 05/18/93 & 05/19/93**

| SOLID MATRIX ANALYSES |                |                                |                                      |                                  |                  |                  |                  |                                  |                                  |        |       |         |       |         |
|-----------------------|----------------|--------------------------------|--------------------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|--------|-------|---------|-------|---------|
| Metals in soils       |                |                                | Results per dry weight basis (mg/kg) |                                  |                  |                  |                  |                                  |                                  |        |       |         |       |         |
| FIELD ID              | As             | Ba                             | Cd                                   | Co                               | Cr               | Cu               | Fe               | Hg                               | Mn                               | Ni     | Pb    | Sb      | Zn    | CYANIDE |
| 22-244-SE-1           | 599            | 43.9                           | 6.4                                  | 8.65                             | 1.82 J           | 39.4             | 6860             | 0.122 J                          | 1780                             | 7.06   | 744   | 4.17 UJ | 393   | NR      |
| 22-244-SE-2           | 879            | 26.1                           | 1.6                                  | 1.37 U                           | 1.15 U           | 27.3             | 7540             | 0.034 J                          | 102                              | 2.01 U | 1190  | 4.2 UJ  | 202   | NR      |
| 22-244-SE-3           | 354            | 284                            | 56.1                                 | 8.35                             | 13.7 J           | 231              | 20700            | 0.274 J                          | 763                              | 7.16   | 995   | 10.9 UJ | 2310  | NR      |
| 22-244-SE-4           | 488            | 40                             | 7.0                                  | 8.18                             | 1.14 U           | 42.3             | 5660             | 0.114 J                          | 1920                             | 8.63   | 561   | 4.16 UJ | 440   | NR      |
| 22-244-TA-1           | 4210           | 46.7                           | 10.8                                 | 1.41 U                           | 2.36 J           | 50.5             | 29500            | 0.111 J                          | 46.9                             | 2.59   | 9380  | 4.32 UJ | 763   | NR      |
| 22-244-TA-2           | 9330           | 53.2                           | 312.0                                | 28.8                             | 19.7 J           | 467              | 57500            | 0.235 J                          | 758                              | 36.6   | 13500 | 31 J    | 33700 | NR      |
| 22-244-TA-3           | 9500           | 95.3                           | 190.0                                | 27                               | 26 J             | 321              | 61400            | 0.106 J                          | 589                              | 37.3   | 9670  | 12.6 J  | 21200 | NR      |
| 22-244-WR-1           | 969            | 48.5                           | 9.2                                  | 1.31                             | 0.936 U          | 87.2             | 6490             | 0.184 J                          | 8.61                             | 1.64 U | 15500 | 6.74 J  | 934   | 1.07U   |
| 22-244-WR-3           | 2570           | 81.2                           | 7.6                                  | 10.8                             | 2.99 J           | 143              | 33600            | 0.156 J                          | 73.7                             | 1.75 U | 7410  | 3.65 UJ | 417   | NR      |
| BACKGROUND            | 10             | 52.7                           | 1.3                                  | 3.15                             | 2.23 J           | 6.12             | 6390             | 0.035 J                          | 284                              | 2.6    | 21.9  | 3.4 UJ  | 43.6  | NR      |
| Acid/Base Accounting  |                |                                |                                      |                                  |                  |                  |                  |                                  |                                  |        |       |         |       |         |
| FIELD ID              | TOTAL SULFUR % | TOTAL SULFUR ACID BASE v/1000t | NEUTRAL. POTENT. v/1000t             | SULFUR ACID BASE POTENT. v/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE v/1000t | SULFUR ACID BASE POTENT. v/1000t |        |       |         |       |         |
| 22-244-TA-1           | 1.49           | 46.5                           | -4.47                                | -51.0                            | 1.33             | 0.06             | 0.10             | 1.87                             | -6.35                            |        |       |         |       |         |
| 22-244-TA-2           | 8.95           | 280                            | 5.17                                 | -274                             | 2.51             | 3.56             | 2.88             | 111                              | -106                             |        |       |         |       |         |
| 22-244-TA-3           | 6.97           | 218                            | -2.24                                | -220                             | 0.31             | 4.84             | 1.82             | 151                              | -153                             |        |       |         |       |         |
| 22-244-WR-1           | 3.00           | 93.7                           | -12.7                                | -106                             | 1.14             | 0.78             | 1.08             | 24.4                             | -37                              |        |       |         |       |         |
| 22-244-WR-3           | 1.33           | 41.5                           | -17.9                                | -59.5                            | 1.07             | 0.09             | 0.17             | 2.81                             | -20.7                            |        |       |         |       |         |
| 0                     | 3.05           | 95.3                           | -12.1                                | -107                             | 1.18             | 0.76             | 1.11             | 23.7                             | -35.9                            |        |       |         |       |         |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**LEGEND**

SE1 - Lump Gulch @ culvert N. of main access road to logging/mine.  
 SE2 - 1/2 way down center drainage @ edge of slurred tailings.  
 SE3 - Outlet of pond S. of access road in Lump Gulch.  
 SE4 - Lump Gulch Creek in tailings deposit downgradient of SW1.  
 TP1 - Sample of the subsample TP1-A1.  
 TP2 - Sample of the subsample TP1-B1.  
 TP3 - Sample of the subsample TP1-B2.  
 WR1 - composite of the subsamples WRD2LRT, LTLT, RTRT, and RTLT  
 WR3 - Composite of the subsamples WRD3-1, 3-3, and 3-4.  
 BACKGROUND - From the Nellie Grant (22-244-SS-1).  
 WR1DUP - Duplicate of the sample 22-244-WR-1.

| WATER MATRIX ANALYSES         |                        |          |                 |           |         |        |        |         |      |        |        |        |                      |      |
|-------------------------------|------------------------|----------|-----------------|-----------|---------|--------|--------|---------|------|--------|--------|--------|----------------------|------|
| Metals in Water               |                        |          | Results in ug/L |           |         |        |        |         |      |        |        |        |                      |      |
| FIELD ID                      | As                     | Ba       | Cd              | Co        | Cr      | Cu     | Fe     | Hg      | Mn   | Ni     | Pb     | Sb     | CALC. Zn(mg CaCO3/L) |      |
| 22-244-GW-1                   | 5.85                   | 5.8      | 2.57            | 5.99 U    | 12.1 J  | 5 J    | 125    | 0.19 J  | 2.77 | 8.78 U | 1.85   | 18.3 U | 6 U                  | 9.98 |
| 22-244-GW-2                   | 3.85                   | 28.3     | 2.55 U          | 5.99 U    | 8.37 J  | 1.35 U | 831    | 0.21 J  | 486  | 8.78 U | 1.36 U | 18.3 U | 6 U                  | 86.7 |
| 22-244-GW-3                   | 53.4                   | 33.2     | 107             | 132       | 13.4 J  | 369 J  | 9270   | 0.13 J  | 3520 | 29.5   | 1090   | 18.3 U | 12700                | 111  |
| 22-244-GW-4                   | 4.28                   | 22.5     | 82.9            | 5.99 U    | 5 U     | 5.2 J  | 13.5 U | 0.091 J | 1320 | 20     | 1.38   | 18.3 U | 10600                | 190  |
| 22-244-SW-1                   | 123                    | 21.2     | 4.37            | 5.99 U    | 7.73 J  | 17.1 J | 1770   | 0.19 J  | 501  | 8.78 U | 98.5   | 18.3 U | 315                  | 14.1 |
| 22-244-SW-2                   | 45.4                   | 19.9     | 559             | 71.8      | 15.3 J  | 720 J  | 3830   | 0.21 J  | 9860 | 87     | 316    | 57.4   | 58900                | 309  |
| 22-244-SW-3                   | 20.6                   | 20       | 263             | 5.99 U    | 5 U     | 19.1 J | 312    | 0.22 J  | 130  | 10.9   | 18.2   | 18.3 U | 2110                 | 27.3 |
| Wet Chemistry Results in mg/l |                        |          |                 |           |         |        |        |         |      |        |        |        |                      |      |
| FIELD ID.                     | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE         | NO3/NO2-N | CYANIDE |        |        |         |      |        |        |        |                      |      |
| 22-244-GW-1                   | 70                     | < 5.0    | < 5             | < 0.05    | NR      |        |        |         |      |        |        |        |                      |      |
| 22-244-GW-2                   | 153                    | < 5.0    | 16              | < 0.05    | NR      |        |        |         |      |        |        |        |                      |      |
| 22-244-GW-3                   | 289                    | < 5.0    | 171             | < 0.05    | NR      |        |        |         |      |        |        |        |                      |      |
| 22-244-GW-4                   | 345                    | < 5.0    | 175             | < 0.05    | NR      |        |        |         |      |        |        |        |                      |      |
| 22-244-SW-1                   | 64                     | < 5.0    | 15              | < 0.05    | NR      |        |        |         |      |        |        |        |                      |      |
| 22-244-SW-2                   | 817                    | < 5.0    | 491             | 0.68      | NR      |        |        |         |      |        |        |        |                      |      |
| 22-244-SW-3                   | 90                     | < 5.0    | 49              | < 0.05    | NR      |        |        |         |      |        |        |        |                      |      |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**LEGEND**

GW1 - Background spring, approximately 35 yards.  
 GW2 - Monitoring well furthest South along access road.  
 GW3 - Shaft #3, East of building.  
 GW4 - Monitoring well furthest North along access road.  
 SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.  
 SW3 - Same as sample SE3.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: General Grant  
Legal Description: T 8N R 5W  
Mining District: Clancy  
Latitude: N 46° 26' 16"  
Longitude: W 112° 12' 07"  
Land Status: Private/Public  
Quad: Chessman Reservoir  
Inspectors: Bullock, Babits, Flammang,  
Lasher, Clark/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Jefferson  
Section(s): SW 1/4, SW 1/4, Sec. 15  
Mine Type: Hardrock/Pb, Zn  
Primary Drainage: Lump Gulch  
USGS Code: 10030101  
Secondary Drainage: Lump Gulch  
Date Investigated: May 19, 1993  
P.A. # 22-245

- There were no tailings on site.
- There were approximately 1,580 cubic yards of waste rock on site. The following elements were elevated at least three times background:  
Arsenic: 2,320 to 5,130 mg/kg      Copper: 55.4 mg/kg  
Mercury: 0.244J to 0.542J mg/kg      Lead: 3,810 to 5,400 mg/kg  
Zinc: 444 mg/kg
- There were no discharging mine openings on site. There was one filled shaft that did not discharge. This shaft was sampled as GW-1 and had a pH 6.47 and specific conductance of 100 umhos/cm. Cadmium exceeded the MCL/MCLG in this sample.
- There was no surface water on site. The nearest surface water was one mile away. No surface water or sediment samples were collected.
- The shaft was hazardous mine openings, but was covered with an AMRB grate.

**General Grant PA# 22-245**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 05/19/93**

| SOLID MATRIX ANALYSES   |                      |   |                               |   |                        |                        |                        |   |   |               |               |               |               |                    |
|---|----------------------|---|-------------------------------|---|------------------------|------------------------|------------------------|---|---|---------------|---------------|---------------|---------------|--------------------|
| Metals in soils<br>Results per dry weight basis   |                      |   |                               |   |                        |                        |                        |   |   |               |               |               |               |                    |
| FIELD ID  | As<br>(mg/Kg)        | Ba<br>(mg/Kg)                           | Cd<br>(mg/Kg)                 | Co<br>(mg/Kg)                             | Cr<br>(mg/Kg)          | Cu<br>(mg/Kg)          | Fe<br>(mg/Kg)          | Hg<br>(mg/Kg)                             | Mn<br>(mg/Kg)                             | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
| 22-245-WR-1   | 2320                 | 55.6                                    | 3.4                           | 1.26 U                                    | 1.05 U                 | 112                    | 10300                  | 0.244 J                                   | 79.5                                      | 1.84 U        | 3810          | 3.84 UJ       | 444           | NR                 |
| 22-245-WR-2   | 5130                 | 44.4                                    | 1.9                           | 1.12 U                                    | 2.42 J                 | 55.4                   | 7970                   | 0.572 J                                   | 2.8                                       | 1.64 U        | 5400          | 4.1 J         | 66            | NR                 |
| BACKGROUND  | 10                   | 52.7                                    | 1.3                           | 3.15                                      | 2.23 J                 | 6.12                   | 6390                   | 0.035 J                                   | 284                                       | 2.6           | 21.9          | 3.4 UJ        | 43.6          | NR                 |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                      |   |                               |   |                        |                        |                        |   |   |               |               |               |               |                    |
| Acid/Base Accounting  |                      |   |                               |   |                        |                        |                        |   |   |               |               |               |               |                    |
| FIELD ID  | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |               |               |               |               |                    |
| 22-245-WR-1   | 0.59                 | 18.4                                    | -4.75                         | -23.2                                     | 0.51                   | 0.02                   | 0.06                   | 0.62                                      | -5.37                                     |               |               |               |               |                    |
| 22-245-WR-2   | 0.51                 | 15.9                                    | -2.46                         | -18.4                                     | 0.47                   | <0.01                  | 0.05                   | 0.00                                      | -2.46                                     |               |               |               |               |                    |

| WATER MATRIX ANALYSES   |                              |          |         |           |         |        |     |        |     |        |      |        |                                      |      |
|---|------------------------------|----------|---------|-----------|---------|--------|-----|--------|-----|--------|------|--------|--------------------------------------|------|
| Metals in Water<br>Results in ug/L  |                              |          |         |           |         |        |     |        |     |        |      |        |                                      |      |
| FIELD ID  | As                           | Ba       | Cd      | Co        | Cr      | Cu     | Fe  | Hg     | Mn  | Ni     | Pb   | Sb     | HARDNESS<br>CALC.<br>Zn (mg CaCO3/L) |      |
| 22-245-GW-1   | 10.7                         | 46.7     | 6.3     | 5.99 U    | 5.67 J  | 1.87 J | 693 | 0.14 J | 568 | 8.78 U | 17.2 | 18.3 U | 773                                  | 33.8 |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                              |          |         |           |         |        |     |        |     |        |      |        |                                      |      |
| Wet Chemistry<br>Results in mg/l  |                              |          |         |           |         |        |     |        |     |        |      |        |                                      |      |
| FIELD I.D.  | TOTAL<br>DISSOLVED<br>SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |        |     |        |     |        |      |        |                                      |      |
| 22-245-GW-1   | 95                           | < 5.0    | 26      | 18        | NR      |        |     |        |     |        |      |        |                                      |      |

**LEGEND**

WR1 - Composite of subsamples WR1-1 and 1-3.

WR2 - Composite of subsamples WR2-1, 2-2, and 2-3.

BACKGROUND - From the Nellie Grant Mine (22-244-SS-1).

GW1 - Discharge from shaft #1 at General Grant.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Alta  
Legal Description: T 7N R 4W  
Mining District: Colorado  
Latitude: N 46° 22' 24"  
Longitude: W 112° 05' 12"  
Land Status: Private  
Quad: Wickes  
Inspectors: Bullock, Belanger/Pierson  
Organization: Pioneer Technical Services,  
Inc./ Thomas, Dean and Hoskins, Inc.

County: Jefferson  
Section(s): SE 1/4, NW 1/4, Sec. 10  
Mine Type: Hardrock/Au, Pb, Ag, Fe, Zn, Cu  
Primary Drainage: Prickly Pear  
USGS Code: 10030101  
Secondary Drainage: Spring Creek  
Date Investigated: August 17, 1993  
P.A. # 22-001

- There were no mill tailings associated with this site.
- Water discharging from the base of WR-1 was apparently a discharge from the main level shaft. This discharge constituted the start of flow in a small, unnamed tributary to Spring Creek. The discharge flow was approximately 10 gpm, pH was measured at 2.59, and specific conductance was 420 umhos/cm. Arsenic, cadmium, copper, nickel, and antimony exceeded MCLs and MCLGs. Acute aquatic life criteria were exceeded for arsenic, iron, cadmium, copper, and zinc. Chronic aquatic life criteria were exceeded for arsenic, mercury, cadmium, copper, and zinc.
- Observed releases to the unnamed tributary (sediment) were documented for arsenic and lead.
- Approximately 175,000 cubic yards of waste rock material was located at this site. The following elements were elevated at least three times background:  
Arsenic: 249J to 658J mg/kg  
Lead: 3100J to 15, 100J mg/kg
- Severe erosion was occurring on several of the waste rock dumps.



**Alta PA# 22-001**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/17/93**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 22-001-SE-1 | 821 J      | 97.4 J     | 1.3 J      | 2.8 J      | 4.1 J      | 230 JX     | 49900 J    | 0.12       | 291 J      | 6 J        | 1170 J     | 6 U        | 613 JX     | NR              |
| 22-001-SE-2 | 46 J       | 120 J      | 0.5 U      | 5 J        | 8.9 J      | 32.3 JX    | 14300 J    | 0.049      | 761 J      | 10 J       | 96 J       | 6 U        | 120 JX     | NR              |
| 22-001-WR-1 | 249 J      | 67.1 J     | 0.5 U      | 1.8 U      | 2.4 J      | 217 JX     | 30100 J    | 0.428      | 291 J      | 4 J        | 3940 J     | 6 U        | 366 JX     | NR              |
| 22-001-WR-2 | 658 J      | 61.5 J     | 1.1 J      | 1.7 U      | 1.2 U      | 193 JX     | 23700 J    | 0.366      | 18.3 J     | 2 J        | 15100 J    | 5 U        | 328 JX     | NR              |
| 22-001-WR-3 | 293 J      | 57 J       | 0.6 J      | 1.9 U      | 1.3 U      | 122 JX     | 12800 J    | 0.437      | 710 J      | 39 J       | 3100 J     | 6 U        | 205 JX     | NR              |
| BACKGROUND  | 187 J      | 92.1       | 6.6        | 11.4       | 8.4 J      | 232 J      | 31600      | 0.029      | 1040       | 11 J       | 447 J      | 6 UJ       | 618        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID       | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|----------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 22-001-WR-1    | 2.8            | 87.5                           | -0.6                    | -88                              | 2.62             | 0.03             | 0.15             | 0.94                             | -1.58                            |
| 22-001-WR-2    | 2.88           | 90                             | -3                      | -93                              | 0.94             | 1.26             | 0.68             | 39.4                             | -42.4                            |
| 22-001-WR-3DUP | 0.88           | 27.5                           | -1.4                    | -29                              | 0.84             | <0.01            | 0.05             | 0                                | -1.44                            |
| 22-001-WR-3    | 0.87           | 27.2                           | -1.6                    | -29                              | 0.82             | <0.01            | 0.06             | 0                                | -1.62                            |

**WATER MATRIX ANALYSES**

**Metals in Water**  
**Results in ug/L**

| FIELD ID    | As   | Ba     | Cd    | Co  | Cr   | Cu      | Fe     | Hg     | Mn     | Ni  | Pb   | Sb  | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|--------|-------|-----|------|---------|--------|--------|--------|-----|------|-----|-----------------|----------------|
| 22-001-SW-1 | 1270 | 2.01 U | 892 J | 206 | 78.5 | 16200 J | 368000 | 0.21 J | 390000 | 117 | 26.3 | 329 | 289000          | 1230           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested; ND - No Data

**Wet Chemistry**  
**Results in mg/l**

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 22-001-SW-1 | 5810                   | ND       | 3450    | < 0.05    | NR      |

**LEGEND**

SE1 - At single stream below waste rock dump 1.  
 SE2 - Upgradient of site.  
 WR1 - Composite of subsamples WR1A, 1B, 1C, 1D, and 1E.  
 WR2 - Composite of subsamples WR2, 3, and 4.  
 WR3 - Composite of subsamples WR5, 6, 7, and 8.  
 BACKGROUND - From the Bertha Mine (22-002-SS-1).  
 WR3DUP - Duplicate of sample 22-001-WR-3.

SW1 - Same as sample SE1.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Bertha  
Legal Description: T 7N R 4W  
Mining District: Colorado  
Latitude: N 46° 22' 55"  
Longitude: W 112° 05' 10"  
Land Status: Private  
Quad: Jefferson City  
Inspectors: Bullock, Flammang, Clark  
Organization: Pioneer Technical Services, Inc.

County: Jefferson  
Section(s): S 1/4, Sec. 3  
Mine Type: Hardrock/Cu, Pb, Ag, Au, Zn  
Primary Drainage: Little Prickly Pear  
USGS Code: 10030101  
Secondary Drainage: Spring Creek  
Date Investigated: July 12, 1993  
P.A. # 22-002

- This site was reclaimed by the MDSL/AMRB in 1987. Waste rock dumps and tailings ponds were almost completely revegetated.
- The volume of tailings associated with this site was roughly estimated at 115,000 cubic yards. Accurate estimation of volume was difficult due to covering and grading activities that occurred during the reclamation activities. The following elements were elevated at least three times background:  
Copper: 2270J to 6320J mg/kg      Mercury: 0.209 to 1.34 mg/kg  
Antimony: 8J to 21J mg/kg
- The volume of waste rock at this site was roughly estimated at 19,000 cubic yards. The following elements were elevated at least three times background:  
Cadmium: 21.3 mg/kg      Copper: 998J to 2290J mg/kg  
Mercury: 0.345 to 2.62 mg/kg      Lead: 8170J mg/kg  
Antimony: 8J to 21J mg/kg
- Spring Creek flowed along the reclaimed waste rock and tailings impoundments. Observed releases to Spring Creek (sediment) were documented for cadmium, copper, lead, and zinc. No MCLs or MCLGs were exceeded in Spring Creek water samples. Acute aquatic life criteria were exceeded for iron both up and down stream of the site. The unnamed tributary coming into Spring Creek from the northwest contained elevated levels of cadmium (25.80J ug/l), copper (1540 ug/l), lead (81.7 ug/l), and zinc (2920J ug/l). MCLs and MCLGs were exceeded for cadmium and copper in this tributary. Acute aquatic life criteria were exceeded for iron, cadmium, copper, and zinc. Chronic aquatic life criteria were exceeded for cadmium, copper, lead, and zinc. Stream flows were approximately 40 gpm in Spring Creek and 30 gpm in unnamed tributary. The pH and specific conductance of Spring Creek below the site was measured at 7.8 and 367 umhos/cm, respectively. The pH and specific conductance of the unnamed tributary was measured at 8.15 and 333 umhos/cm, respectively.

**Bertha PA# 22-002**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 06/22/93**

| SOLID MATRIX ANALYSES |            |                              |            |            |            |            |            |            |            |            |            |            |            |                 |
|-----------------------|------------|------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| Metals in soils       |            | Results per dry weight basis |            |            |            |            |            |            |            |            |            |            |            |                 |
| FIELD ID              | As (mg/Kg) | Ba (mg/Kg)                   | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 22-002-SE-1           | 19 J       | 37.4                         | 3.9        | 8.5        | 7 J        | 395 J      | 15100      | 0.015      | 740        | 7 J        | 223 J      | 6 UJ       | 739        | NR              |
| 22-002-SE-2           | 78 J       | 51.6                         | 2.7        | 8.1        | 11.3 J     | 186 J      | 29800      | 0.022      | 412        | 9 J        | 168 J      | 7 UJ       | 384        | NR              |
| 22-002-SE-3           | 33 J       | 46.7                         | 1.2        | 10.8       | 9.9 J      | 78.1 J     | 22400      | 0.014      | 476        | 10 J       | 68 J       | 6 UJ       | 121        | NR              |
| 22-002-TP-1           | 90 J       | 34.7                         | 7.6        | 6.4        | 1.5 U      | 6320 J     | 35400      | 1.34       | 1120       | 9 J        | 588 J      | 21 J       | 1200       | NR              |
| 22-002-TP-2           | 44 J       | 32.7                         | 3          | 4.1        | 3.6 J      | 2270 J     | 17400      | 0.209      | 485        | 5 J        | 245 J      | 8 J        | 371        | NR              |
| 22-002-WR-1           | 420 J      | 70.9                         | 21.3       | 3.6        | 1.1 U      | 2290 J     | 45700      | 2.62       | 362        | 2 U        | 8170 J     | 25 J       | 2520       | NR              |
| 22-002-WR-2           | 30 J       | 38.7                         | 4.4        | 7.7        | 3.8 J      | 998 J      | 27000      | 0.345      | 607        | 10 J       | 292 J      | 6 UJ       | 472        | NR              |
| BACKGROUND            | 187 J      | 92.1                         | 6.6        | 11.4       | 8.4 J      | 232 J      | 31600      | 0.029      | 1040       | 11 J       | 447 J      | 6 UJ       | 618        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID       | TOTAL SULFUR % | TOTAL SULFUR ACID BASE U/1000t | NEUTRAL POTENT. U/1000t | SULFUR ACID BASE POTENT. U/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE U/1000t | SULFUR ACID BASE POTENT. U/1000t |
|----------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 22-002-TP-1    | 3.6            | 112                            | 38.2                    | -74                              | 0.23             | 2.56             | 0.81             | 80                               | -41.7                            |
| 22-002-TP-2DUP | 0.59           | 18.4                           | 3.86                    | -15                              | 0.35             | 0.05             | 0.19             | 1.56                             | 2.3                              |
| 22-002-TP-2    | 0.6            | 18.7                           | 3.89                    | -15                              | 0.35             | 0.09             | 0.16             | 2.81                             | 1.08                             |
| 22-002-WR-1    | 4.19           | 131                            | -11                     | -142                             | 1.84             | 0.91             | 1.44             | 28.4                             | -39.3                            |
| 22-002-WR-2    | 2.33           | 72.8                           | 104                     | 31.6                             | 1.19             | 0.44             | 0.7              | 13.7                             | 90.7                             |

| WATER MATRIX ANALYSES |         |                 |         |        |        |       |         |       |      |        |      |        |                 |                |
|-----------------------|---------|-----------------|---------|--------|--------|-------|---------|-------|------|--------|------|--------|-----------------|----------------|
| Metals in Water       |         | Results in ug/L |         |        |        |       |         |       |      |        |      |        |                 |                |
| FIELD ID              | As      | Ba              | Cd      | Co     | Cr     | Cu    | Fe      | Hg    | Mn   | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
| 22-002-SW-1           | 9.14 J  | 19.90           | 3.27 J  | 9.70 U | 6.83 U | 19.80 | 7220 JX | 0.120 | 158  | 12.7 U | 2.87 | 30.7 U | 62.5 J          | 178            |
| 22-002-SW-2           | 10.91 J | 81.20           | 25.80 J | 9.70 U | 6.83 U | 1540  | 3710 JX | 0.110 | 1620 | 22.5   | 81.7 | 30.7 U | 2920 J          | 324            |
| 22-002-SW-3           | 5.58 J  | 73.30           | 2.57 U  | 9.70 U | 6.83 U | 19.00 | 2770 JX | 0.150 | 153  | 12.7 U | 15.1 | 30.7 U | 109 J           | 211            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Wet Chemistry**

**Results in mg/l**

| FIELD I.D.  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 22-002-SW-1 | 526                    | < 5.0    | 253     | < 0.05    | NR      |
| 22-002-SW-2 | 352                    | < 5.0    | 115     | < 0.05    | NR      |
| 22-002-SW-3 | 340                    | < 5.0    | 113     | < 0.05    | NR      |

**LEGEND**

SE1 - Spring Creek immediately downgradient of tailings pond 2.  
 SE2 - Unnamed tributary to Spring Creek which flows past Northern workings.  
 SE3 - Spring Creek upgradient of tailings pond 1.  
 TP1 - Sample of the TP1A subsample.  
 TP2 - Composite of subsamples TP3A-A, 3A-B, 3B-A, 3B-B, 3B-C, 3B-D, and 3C-A through 3C-C.  
 WR1 - Composite of subsamples WR1A, 1B, and 1C.  
 WR2 - Composite of subsamples WR2A and 2B.

BACKGROUND - From the Bertha Mine (22-002-S3-1).  
 SW1 - Same as sample Se1.  
 SW2 - Same as sample SE2.  
 SW3 - Same as sample SE3.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |  |
|--|--|
| Mine/Site Name: <u>Bluebird</u>  | County: <u>Jefferson</u>                   |
| Legal Description: T <u>7N</u> R <u>5W</u>   | Section(s): <u>N 1/2, All 1/4, Sec. 13</u> |
| Mining District: <u>Colorado</u>   | Mine Type: <u>Hardrock//Au, Ag</u>         |
| Latitude: <u>N 46° 21' 32"</u>   | Primary Drainage: <u>Spring Creek</u>      |
| Longitude: <u>W 112° 10' 00"</u>   | USGS Code: <u>10030101</u>                 |
| Land Status: <u>Private/Public</u>   | Secondary Drainage: <u>Curtain Gulch</u>   |
| Quad: <u>Mount Thompson</u>  | Date Investigated: <u>July 8, 1993</u>     |
| Inspectors: <u>Babits, Lasher/Pierson</u>  | P.A. # <u>22-003</u>                       |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |  |

- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 70,550 cubic yards. The following elements were elevated at least three times background:

|                               |                   |
|-------------------------------|-------------------|
| Arsenic: 100JX to 587JX mg/kg | Copper: 441 mg/kg |
| Mercury: 0.407J mg/kg         | Lead: 4,990 mg/kg |
| Zinc: 1,910 mg/kg             |                   |
- Three discharging adits were identified at the site during the investigation; all of these discharges entered Curtain Creek. One sample was collected for laboratory analysis. MCLs for arsenic, cadmium, and copper were exceeded in the adit discharge. Acute and chronic aquatic life criteria were exceeded for cadmium, copper, and zinc and chronic aquatic life criteria were exceeded for iron and lead.
- Curtain Creek flowed directly through two waste rock dumps at the site. Observed releases to Curtain Creek were documented for arsenic, copper, and zinc. The MCL for cadmium was exceeded in the downstream surface water sample; however, the exceedance was not attributable to the site. Acute and chronic aquatic life criteria for copper and zinc were exceeded in the downstream sample; these exceedances were directly attributable to the site.
- One potentially hazardous partially collapsed shaft was identified at the site.



**Blue Bird PA# 22-003**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/08/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 22-003-WR-1 | 587 JX        | 50.6          | 1.4           | 14.2          | 19.8          | 441           | 47000         | 0.407 J       | 1440 J        | 11            | 4990          | 11 J          | 1910          | NR                 |
| 22-003-WR-2 | 100 JX        | 37.1          | 0.5 U         | 4             | 3.9           | 18.9          | 31400         | 0.102 J       | 584 J         | 3 U           | 29            | 6 UJ          | 45            | NR                 |
| BACKGROUND  | 28 JX         | 123           | 0.7           | 14.9          | 24.3          | 50.4          | 25400         | 0.052 J       | 1810 J        | 14            | 258           | 5 UJ          | 255           | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR ACID BASE<br>t/1000t | NEUTRAL POTENT.<br>t/1000t | SULFUR ACID BASE POTENT.<br>t/1000t | SULFATE SULFUR<br>% | PYRITIC SULFUR<br>% | ORGANIC SULFUR<br>% | PYRITIC SULFUR ACID BASE<br>t/1000t | SULFUR ACID BASE POTENT.<br>t/1000t |
|-------------|-------------------|-----------------------------------|----------------------------|-------------------------------------|---------------------|---------------------|---------------------|-------------------------------------|-------------------------------------|
| 22-003-WR-1 | 1.06              | 33.1                              | 9.94                       | -23                                 | 0.92                | 0.02                | 0.12                | 0.62                                | 9.31                                |
| 22-003-WR-2 | 0.21              | 6.56                              | 78.6                       | 72                                  | 0.1                 | 0.03                | 0.08                | 0.94                                | 77.7                                |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu     | Fe      | Hg      | Mn      | Ni     | Pb      | Sb     | HARDNESS<br>CALC.<br>Zn (mg CaCO3/L) |
|-------------|--------|------|--------|-------|--------|--------|---------|---------|---------|--------|---------|--------|--------------------------------------|
| 22-003-SW-1 | 142    | 12.1 | 25.1   | 16.2  | 6.83 U | 1620 J | 19000 J | 0.038 U | 4590 JX | 12.7 U | 8.21 JX | 30.7 U | 3600 J 206                           |
| 22-003-SW-2 | 2.64 J | 4.93 | 2.57 U | 9.7 U | 6.83 U | 3.13 J | 29.9    | 0.210 J | 4.08 U  | 12.7 U | 6.81 J  | 30.7 U | 7.57 U 37.4                          |
| 22-003-SW-4 | 31.7   | 8.77 | 12.2   | 9.7 U | 9.33 J | 605 J  | 4700 J  | 0.038 U | 1390 JX | 12.7 U | 13 JX   | 30.7 U | 1540 J 113                           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED<br>SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|---------------------------|----------|---------|-----------|---------|
| 22-003-SW-1 | 375                       | < 5.0    | 173     | < 0.05    | NR      |
| 22-003-SW-2 | 91                        | < 5.0    | 11      | 0.05      | NR      |
| 22-003-SW-4 | 217                       | < 5.0    | 81      | < 0.05    | NR      |

**LEGEND**

WR1 - Composite of subsamples WR1A, 1B, 1C, and 2.  
WR2 - Composite of subsamples WR3A, 3B, 3C, and 4.  
BACKGROUND - 300 feet above discharging adit.  
From Bluebird Mine (22-003-SS-1).

SW1 - At uppersite adit discharge.  
SW2 - At uppersite spring headwaters.  
SW4 - The downgradient spring sample after confluence with three adit discharges.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Corbin Flats  
Legal Description: T 7N R 4W  
Mining District: Colorado  
Latitude: N 46° 23' 13"  
Longitude: W 112° 02' 30"  
Land Status: Private  
Quad: Jefferson City  
Inspectors: Tuesday, Belanger, Lasher  
Organization: Pioneer Technical Services, Inc.

County: Jefferson  
Section(s): S 1/2, Sec. 1  
Mine Type: Mill/Cu, Pb, Zn  
Primary Drainage: Prickly Pear Creek  
USGS Code: 10030101  
Secondary Drainage: Spring Creek  
Date Investigated: July 12, 1993  
P.A. # 22-004

- The volume of partially revegetated tailings associated with this site was estimated to be approximately 700,000 cubic yards. The following elements were elevated at least three times background:

|                               |                                   |
|-------------------------------|-----------------------------------|
| Arsenic: 975J to 1,270J mg/kg | Manganese: 17,500 to 20,400 mg/kg |
| Cadmium: 61.7 to 104 mg/kg    | Lead: 7,540J to 15,500J mg/kg     |
| Copper: 897J to 2,010J mg/kg  | Antimony: 104J to 194J mg/kg      |
| Mercury: 0.31 to 1.45 mg/kg   | Zinc: 9,360 to 13,500 mg/kg       |
- Spring Creek was observed flowing directly through the tailings; although, it appeared that previous attempts were made to reroute the creek to the north of the tailings. The MCL for cadmium was exceeded in both upstream and downstream samples from Spring Creek; the MCL for arsenic was exceeded in the downstream sample. Acute and chronic aquatic life criteria for cadmium, copper, and zinc and the chronic aquatic life criteria for mercury were exceeded in both upstream and downstream samples. Acute and chronic aquatic life criteria for lead and the chronic aquatic life criteria for iron were exceeded in the downstream sample. Metals concentrations measured in upstream and downstream sediment samples were very similar to background concentrations.
- Observed releases to Spring Creek were documented for arsenic and lead. The MCL exceedance for arsenic and the acute and chronic aquatic life criteria exceedances for lead in the downstream sample were directly attributable to the site.
- A residential well located adjacent to and downgradient from the site was sampled during the investigation. No MCLs were exceeded.
- Several residences were located near the site, and the area was observed being used for recreational purposes during the investigation. The site had a high potential for hazardous dust propagation.

**Corbin Flats PA# 22-004**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 07/12/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 22-004-SE-1 | 104 J      | 34.5       | 3.2        | 4.3        | 4.5 J      | 76.6 J     | 12800      | 0.104      | 458        | 5 J        | 223 J      | 6 UJ       | 506        | NR              |
| 22-004-SE-2 | 63 J       | 20.3       | 3.3        | 3          | 1.6 U      | 161 J      | 9460       | 0.026      | 1320       | 3 J        | 204 J      | 7 UJ       | 561        | NR              |
| 22-004-TP-1 | 1270 J     | 66.5       | 61.7       | 2.6        | 2.3 J      | 897 J      | 20400      | 0.31       | 20400      | 20 J       | 7540 J     | 104 J      | 9360       | NR              |
| 22-004-TP-2 | 975 J      | 87.9       | 104        | 5.1        | 4.2 J      | 2010 J     | 27800      | 1.45       | 17500      | 19 J       | 15500 J    | 194 J      | 13500      | NR              |
| BACKGROUND  | 187 J      | 92.1       | 6.6        | 11.4       | 8.4 J      | 232 J      | 31600      | 0.029      | 1040       | 11 J       | 447 J      | 6 UJ       | 618        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 22-004-TP-1 | 1.5            | 46.9                           | 3.2                      | -44                              | 0.59             | 0.56             | 0.35             | 17.5                             | -14.3                            |
| 22-004-TP-2 | 2.66           | 83.1                           | 66.6                     | -17                              | 0.84             | 1.07             | 0.75             | 33.4                             | 33.2                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As      | Ba    | Cd     | Co     | Cr     | Cu   | Fe      | Hg    | Mn   | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|---------|-------|--------|--------|--------|------|---------|-------|------|--------|------|--------|-----------------|----------------|
| 22-004-GW-1 | 9.12 J  | 30.70 | 4.03 J | 9.70 U | 6.83 U | 3.70 | 76.1 JX | 0.120 | 18.1 | 12.7 U | 3.95 | 30.7 U | 66.8 J          | 197            |
| 22-004-SW-1 | 20.51 J | 8.40  | 241 J  | 11.00  | 6.83 U | 233  | 630 JX  | 0.095 | 8580 | 59.3   | 17.3 | 44.1   | 26300 J         | 536            |
| 22-004-SW-2 | 103     | 50.6  | 25.1 J | 9.7 U  | 7.97   | 348  | 6530    | 0.094 | 8830 | 12.7 U | 960  | 30.7 U | 5630            | 215            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 22-004-GW-1 | 686                    | < 5.0    | 156     | < 0.05    | NR      |
| 22-004-SW-1 | 326                    | < 5.0    | 144     | 0.36      | NR      |
| 22-004-SW-2 | 406                    | < 5.0    | 206     | 0.24      | NR      |

**LEGEND**

SE1 - Upstream in Spring Creek.  
SE2 - Downstream of tailings in Spring Creek.  
TP1 - Composite of subsamples TP1A-A, 1B-1 through 1B-3, and 1C-1 through 1C-4.  
TP2 - Composite of subsamples TP1D-1 through 1D-4.  
BACKGROUND - From the Bertha Mine (22-002-SS-1).

GW1 - Residential well.  
SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Gregory  
Legal Description: T 7N R 4W  
Mining District: Colorado  
Latitude: N 46° 23' 14"  
Longitude: W 112° 06' 48"  
Land Status: Private  
Quad: Jefferson City  
Inspectors: Bullock, Belanger, Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Jefferson  
Section(s): N 1/2, Sec. 4  
Mine Type: Hardrock/Pb, Zn, Au, Ag  
Primary Drainage: Clancy Creek  
USGS Code: 10030101  
Secondary Drainage: Clancy Creek  
Date Investigated: August 17, 1993  
P.A. # 22-005

- Approximately 10,000 cubic yards of tailings were associated with this site. The following elements were elevated at least three times background:  
Arsenic: 5870J mg/kg
- The volume of waste rock at this site was approximately 30,000 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 770J to 1060J mg/kg  
Mercury: 0.412 to 0.544 mg/kg  
Lead: 4910J to 11500J mg/kg
- Erosion of waste rock and tailings into drainages was occurring.
- An observed release to Clancy Creek was documented for lead. Also, the acute aquatic life criteria for copper was exceeded in Clancy Creek, which was directly attributable to the site. Observed releases to the unnamed tributary of Clancy Creek were documented for arsenic and lead. The MCL for cadmium was also exceeded in this tributary; however, the exceedance could not be attributed to the site. The pH of Clancy Creek dropped from 7.73 to 7.58 between the up- and down-gradient sample locations. Specific conductance increased from 190 to 240 umhos/cm. The unnamed tributary made up less than 5 percent of the flow of Clancy Creek at this location.



**Gregory PA# 22-005**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/17/93**

**SOLID MATRIX ANALYSES**

| SOLID MATRIX ANALYSES |              |                              |                 |                          |                |                |                |                |                  |   |            |            |            |                 |
|-----------------------|--------------|------------------------------|-----------------|--------------------------|----------------|----------------|----------------|----------------|------------------|---|------------|------------|------------|-----------------|
| Metals in soils       |              | Results per dry weight basis |                 |                          |                |                |                |                |                  |   |            |            |            |                 |
| FIELD ID              | As (mg/Kg)   | Ba (mg/Kg)                   | Cd (mg/Kg)      | Co (mg/Kg)               | Cr (mg/Kg)     | Cu (mg/Kg)     | Fe (mg/Kg)     | Hg (mg/Kg)     | Mn (mg/Kg)       | Ni (mg/Kg)  | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 22-005-SE-3           | 5820 J       | 92.1 J                       | 6.6 J           | 5.67 U                   | 8.67           | 331            | 90700          | 0.208          | 334              | 7.4 U   | 2180 J     | 17.9 U     | 1060 J     | NR              |
| 22-005-SE-5           | 22 J         | 125 J                        | 0.5 U           | 6.5 J                    | 11.1 J         | 14.1 JX        | 13200 J        | 0.039          | 908 J            | 30 J  | 83 J       | 6 U        | 158 JX     | NR              |
| 22-005-TP-1           | 5870 J       | 81.2 J                       | 1.4 J           | 1.8 J                    | 4.4 J          | 161 JX         | 21700 J        | 0.063          | 60.8 J           | 6 J   | 577 J      | 5 U        | 195 JX     | NR              |
| 22-005-TP-2           | 1740 J       | 104 J                        | 0.8 J           | 4.3 J                    | 8.2 J          | 204 JX         | 19700 J        | 0.04           | 705 J            | 5 J   | 347 J      | 7 U        | 273 JX     | NR              |
| 22-005-WR-1           | 1060 J       | 45.5 J                       | 4.1 J           | 3 J                      | 1.2 U          | 453 JX         | 35500 J        | 0.457          | 163 J            | 14 J  | 11500 J    | 5 U        | 1090 JX    | NR              |
| 22-005-WR-2           | 381 J        | 90.4 J                       | 0.6 U           | 2.1 U                    | 1.5 U          | 168 JX         | 30100 J        | 0.412          | 70.5 J           | 8 J   | 4910 J     | 7 U        | 220 JX     | NR              |
| 22-005-WR-3           | 770 J        | 101 J                        | 0.6 J           | 2.3 J                    | 8 J            | 129 JX         | 58400 J        | 0.544          | 181 J            | 9 J   | 6790 J     | 6 U        | 563 JX     | NR              |
| BACKGROUND            | 187 J        | 92.1                         | 6.6             | 11.4                     | 8.4 J          | 232 J          | 31600          | 0.029          | 1040             | 11 J  | 447 J      | 6 UJ       | 618        | NR              |
| Acid/Base Accounting  |              |                              |                 |                          |                |                |                |                |                  |   |            |            |            |                 |
| FIELD ID              | TOTAL SULFUR | TOTAL SULFUR ACID BASE       | NEUTRAL POTENT. | SULFUR ACID BASE POTENT. | SULFATE SULFUR | PYRITIC SULFUR | ORGANIC SULFUR | PYRITIC SULFUR | SULFUR ACID BASE | U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |            |            |            |                 |
|                       | %            | 1/1000t                      | 1/1000t         | 1/1000t                  | %              | %              | %              | 1/1000t        | 1/1000t          |   |            |            |            |                 |
| 22-005-TP-1           | 0.48         | 15                           | -6.7            | -22                      | 0.46           | <0.01          | 0.02           | 0              | -6.73            |   |            |            |            |                 |
| 22-005-TP-2           | 0.29         | 9.06                         | -3.3            | -12                      | 0.24           | 0.01           | 0.04           | 0.31           | -3.61            |   |            |            |            |                 |
| 22-005-WR-1           | 3.98         | 124                          | -7.3            | -132                     | 1.75           | 1.52           | 0.71           | 47.5           | -54.8            |   |            |            |            |                 |
| 22-005-WR-2           | 1.87         | 58.4                         | -3.7            | -62                      | 0.94           | 0.47           | 0.46           | 14.7           | -18.4            |   |            |            |            |                 |
| 22-005-WR-2DUP        | 1.9          | 59.4                         | -3.3            | -63                      | 0.98           | 0.43           | 0.49           | 13.4           | -16.7            |   |            |            |            |                 |
| 22-005-WR-3           | 2.1          | 65.6                         | -5.8            | -71                      | 2.03           | 0.01           | 0.06           | 0.31           | -6.1             |   |            |            |            |                 |
| 22-005-WR-3DUP        | 2.13         | 66.5                         | -6.3            | -73                      | 2.05           | 0.01           | 0.07           | 0.31           | -6.34            |   |            |            |            |                 |

**WATER MATRIX ANALYSES**

| Metals in Water   |           | Results in ug/L |         |           |         |   |  |        |       |        |      |        |                       | WATER MATRIX ANALYSES   |   |  |
|---|-----------|-----------------|---------|-----------|---------|---|--|--------|-------|--------|------|--------|-----------------------|---|---|--|
| FIELD ID  | As        | Ba              | Cd      | Co        | Cr      | Cu  | Fe   | Hg     | Mn    | Ni     | Pb   | Sb     | CALC. Zn (mg CaCO3/L) |   |   |  |
| 22-005-SW-1   | 4.45      | 7.13            | 2.93 J  | 9.7 U     | 6.83 U  | 39.5 J  | 146  | 0.27 J | 591   | 12.7 U | 14.4 | 30.7 U | 640                   | 89.2  |   |  |
| 22-005-SW-2   | 3.17      | 5.8             | 3 J     | 9.7 U     | 6.83 U  | 2.5 J   | 105  | 0.22 J | 91.9  | 15.5   | 0.75 | 30.7 U | 31.1                  | 76  |   |  |
| 22-005-SW-3   | 30.3      | 20.2            | 84.9 J  | 33.7      | 8.07    | 1020 J  | 10800  | 0.34 J | 14000 | 22.3   | 200  | 36.5   | 14900                 | 316   |   |  |
| 22-005-SW-4   | 216       | 2.01 U          | 135 J   | 38.8      | 6.83 U  | 2230 J  | 51700  | 0.39 J | 9670  | 31.7   | 48.1 | 30.7 U | 20400                 | 156   |   |  |
| 22-005-SW-5   | 4.81      | 43.7            | 2.57 U  | 9.7 U     | 6.83 U  | 1.55 U  | 510  | 0.29 J | 133   | 14.6   | 3.73 | 30.7 U | 29.9                  | 177   |   |  |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |           |                 |         |           |         |   |  |        |       |        |      |        |                       |   |   |  |
| Wet Chemistry   |           | Results in mg/l |         |           |         |   | LEGEND   |        |       |        |      |        |                       |   |   |  |
| FIELD   | TOTAL     |                 |         |           |         |   | SE3 - Downstream tributary sample above culvert. |        |       |        |      |        |                       |   | SW1 - Clancy Creek downstream from tailings and confluence. |  |
|   | DISSOLVED |                 |         |           |         |   | SE5 - Upgradient tributary sample.               |        |       |        |      |        |                       |   |   |  |
| I.D.  | SOLIDS    | CHLORIDE        | SULFATE | NO3/NO2-N | CYANIDE | TP1 - Sample of the TP1 subsample.                                |  |        |       |        |      |        |                       | SW2 - Upstream Clancy Creek at Pegasus gaging station.                          |   |  |
| TP2 - Composite of subsample TP2A and 2B.   |           |                 |         |           |         |   |  |        |       |        |      |        |                       |   |   |  |
| 22-005-SW-1   | 161       | < 5.0           | 58      | < 0.05    | NR      | WR1 - Composite of subsamples WR1A through 1E, and 2A through 2C. |  |        |       |        |      |        |                       | SW3 - Downstream tributary sample above culvert.                                |   |  |
| 22-005-SW-2   | 131       | < 5.0           | 30      | < 0.05    | NR      | WR2 - Composite of subsamples WR3A through 3C.                    |  |        |       |        |      |        |                       | SW4 - Mouth of small Northern tributary coming downstream of waste rock dump 2. |   |  |
| 22-005-SW-3   | 851       | < 5.0           | 556     | 0.07      | NR      | WR3 - Composite of subsamples WR4A and 4B.                        |  |        |       |        |      |        |                       |   |   |  |
| 22-005-SW-4   | 878       | < 5.0           | 586     | < 0.05    | NR      | BACKGROUND - From the Bertha Mine (22-002-S8-1).                  |  |        |       |        |      |        |                       |   |   |  |
| 22-005-SW-5   | 260       | < 5.0           | 97      | < 0.05    | NR      | WR2DUP - Duplicate of the 22-005-WR-2 sample.                     |  |        |       |        |      |        |                       |   |   |  |
| WR3DUP - Duplicate of the 22-005-WR-3 sample.   |           |                 |         |           |         |   |  |        |       |        |      |        |                       |   |   |  |

**LEGEND**

- SE3 - Downstream tributary sample above culvert.  
SE5 - Upgradient tributary sample.  
TP1 - Sample of the TP1 subsample.  
TP2 - Composite of subsample TP2A and 2B.  
WR1 - Composite of subsamples WR1A through 1E, and 2A through 2C.  
WR2 - Composite of subsamples WR3A through 3C.  
WR3 - Composite of subsamples WR4A and 4B.  
BACKGROUND - From the Bertha Mine (22-002-SS-1).  
WR2DUP - Duplicate of the 22-005-WR-2 sample.  
WR3DUP - Duplicate of the 22-005-WR-3 sample.
- SW1 - Clancy Creek downstream from tailings and confluence.  
SW2 - Upstream Clancy Creek at Pegasus gaging station.  
SW3 - Downstream tributary sample above culvert.  
SW4 - Mouth of small Northern tributary coming downstream of waste rock dump 2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |   |
|--|---|
| Mine/Site Name: <u>Washington</u>  | County: <u>Jefferson</u>                      |
| Legal Description: <u>T 7N R 4W</u>  | Section(s): <u>SW 1/4, NW 1/4, Sec. 17</u>    |
| Mining District: <u>Colorado</u>   | Mine Type: <u>Hardrock/Au, Ag, Cu, Pb, Zn</u> |
| Latitude: <u>N 46° 21' 39"</u>   | Primary Drainage: <u>Prickly Pear Creek</u>   |
| Longitude: <u>W 112° 08' 14"</u>   | USGS Code: <u>10030101</u>                    |
| Land Status: <u>Private</u>  | Secondary Drainage: <u>Spring Creek</u>       |
| Quad: <u>Mount Thompson</u>  | Date Investigated: <u>August 16, 1993</u>     |
| Inspectors: <u>Bullock, Belanger, Pierson</u>  | P.A. # <u>22-007</u>                          |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |   |

- The volume of tailings associated with this site was estimated to be approximately 86,000 cubic yards. The following elements were elevated at least three times background:

|                                 |                               |
|---------------------------------|-------------------------------|
| Arsenic: 9180J to 11,000J mg/kg | Cadmium: 31.9J to 68.9J mg/kg |
| Iron: 95,700J to 101,000J mg/kg | Mercury: 0.207 mg/kg          |
| Lead: 4310J to 5830J mg/kg      | Antimony: 43 mg/kg            |
| Zinc: 5660JX to 10700JX mg/kg   |                               |
- Tailings were actively eroding into this tributary of Spring Creek.
- The volume of waste rock associated with this site was estimated to be approximately 36,000 cubic yards. The following elements were elevated at least three times background:

|                               |                               |
|-------------------------------|-------------------------------|
| Arsenic: 2410J to 3250J mg/kg | Cadmium: 16.4J to 20.8J mg/kg |
| Mercury: 0.384 to 0.39 mg/kg  | Lead: 2330J to 4420J mg/kg    |
| Antimony: 19 mg/kg            | Zinc: 5660JX to 10700JX mg/kg |
- Two adit discharges were associated with this site, making up all of the flow of this tributary of Spring Creek during mid-summer, low-flow conditions. Both adit discharges exceeded the MCL for arsenic. Acute aquatic life criteria were exceeded for iron and zinc at both adits and for arsenic at Adit #1. Chronic aquatic life criteria were exceeded for zinc at both adits and also for arsenic and cadmium at Adit #1. Adit discharge pH measurements were 7.86 and 7.27 for Adit #1 and Adit #2, respectively.
- This tributary to Spring Creek flowed intermittently above the adit discharges and below it flowed through the waste rock and tailings. Observed releases were observed for arsenic, lead and zinc. The chronic aquatic life criteria for lead was exceeded and was directly attributed to this site. The upgradient surface water sample indicated the presence of an upgradient contaminant source.

**Washington PA# 22-007**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/16/93**

| SOLID MATRIX ANALYSES   |                 |                        |                              |                          |                |                |                |                          |                          |            |            |            |            |                 |
|---|-----------------|------------------------|------------------------------|--------------------------|----------------|----------------|----------------|--------------------------|--------------------------|------------|------------|------------|------------|-----------------|
| FIELD ID  | Metals in soils |                        | Results per dry weight basis |                          |                |                |                |                          |                          |            |            |            |            |                 |
|   | As (mg/Kg)      | Ba (mg/Kg)             | Cd (mg/Kg)                   | Co (mg/Kg)               | Cr (mg/Kg)     | Cu (mg/Kg)     | Fe (mg/Kg)     | Hg (mg/Kg)               | Mn (mg/Kg)               | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 22-007-SE-1   | 5100            | 28.4                   | 32.7 J                       | 7.2                      | 8.6            | 156            | 46400          | 0.084                    | 3210                     | 9          | 2280       | 34         | 5080       | NR              |
| 22-007-SE-2   | 44              | 29.9                   | 2.6 J                        | 12.6                     | 32.6           | 33.6           | 22900          | 0.028 U                  | 875                      | 21         | 133        | 6 U        | 184        | NR              |
| 22-007-TP-1   | 9180 J          | 20.8 J                 | 31.9 J                       | 13.2 J                   | 7.6 J          | 293 JX         | 95700 J        | 0.207                    | 2770 J                   | 19 J       | 5830 J     | 43         | 5660 JX    | NR              |
| 22-007-TP-2   | 11000 J         | 13.3 J                 | 68.9 J                       | 17.7 J                   | 19.9 J         | 280 JX         | 101000 J       | 0.08                     | 6360 J                   | 24 J       | 4310 J     | 6 U        | 10700 JX   | NR              |
| 22-007-WR-1   | 2410            | 26.6                   | 16.4 J                       | 5.6                      | 7.9            | 53.8           | 30900          | 0.384                    | 1470                     | 6          | 2330       | 16         | 2970       | NR              |
| 22-007-WR-2   | 3250            | 24.1                   | 20.8 J                       | 4.3                      | 3.9            | 67.2           | 33700          | 0.39                     | 987                      | 6          | 4420       | 19         | 3010       | NR              |
| BACKGROUND  | 187 J           | 92.1                   | 6.6                          | 11.4                     | 8.4 J          | 232 J          | 31600          | 0.029                    | 1040                     | 11 J       | 447 J      | 6 UJ       | 618        | NR              |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                 |                        |                              |                          |                |                |                |                          |                          |            |            |            |            |                 |
| Acid/Base Accounting  |                 |                        |                              |                          |                |                |                |                          |                          |            |            |            |            |                 |
| FIELD ID  | TOTAL SULFUR    | TOTAL SULFUR ACID BASE | NEUTRAL. POTENT.             | SULFUR ACID BASE POTENT. | SULFATE SULFUR | PYRITIC SULFUR | ORGANIC SULFUR | PYRITIC SULFUR ACID BASE | SULFUR ACID BASE POTENT. |            |            |            |            |                 |
|   | %               | lb/1000t               | lb/1000t                     | lb/1000t                 | %              | %              | %              | lb/1000t                 | lb/1000t                 |            |            |            |            |                 |
| 22-007-TP-1   | 11.7            | 366                    | 47.5                         | -318                     | <0.01          | 10.2           | 1.65           | 319                      | -271                     |            |            |            |            |                 |
| 22-007-TP-2   | 10.6            | 331                    | 124                          | -207                     | <0.01          | 10.8           | 2.35           | 337                      | -213                     |            |            |            |            |                 |
| 22-007-TP-2DUP  | 10.3            | 322                    | 124                          | -199                     | <0.01          | 10.8           | 2.38           | 337                      | -214                     |            |            |            |            |                 |
| 22-007-WR-1   | 4.89            | 153                    | 48.6                         | -104                     | 0.10           | 1.38           | 3.41           | 43.1                     | 5.54                     |            |            |            |            |                 |
| 22-007-WR-2   | 4.13            | 129                    | 29.0                         | -100                     | 2.39           | 0.41           | 1.33           | 12.8                     | 16.2                     |            |            |            |            |                 |

| WATER MATRIX ANALYSES   |                        |                 |         |           |         |  |         |         |         |        |      |        |                 |          |  |  |  |
|---|------------------------|-----------------|---------|-----------|---------|--|---------|---------|---------|--------|------|--------|-----------------|----------|--|--|--|
| Metals in Water   |                        | Results in ug/L |         |           |         |  |         |         |         |        |      |        |                 | HARDNESS |  |  |  |
| FIELD ID  | As                     | Ba              | Cd      | Co        | Cr      | Cu   | Fe      | Hg      | Mn      | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | CALC.    |  |  |  |
| 22-007-GW-1   | 621                    | 21.2            | 2.57 U  | 9.7 U     | 9.57 J  | 2.03   | 3660 J  | 0.260 J | 1740 JX | 12.7 U | 2.35 | 30.7 U | 336             | 245      |  |  |  |
| 22-007-GW-2   | 172                    | 21.5            | 2.57 U  | 10.6      | 6.83 U  | 3.3  | 17700 J | 0.160 J | 3630 JX | 12.7 U | 4.27 | 30.7 U | 2230            | 367      |  |  |  |
| 22-007-SW-1   | 1060                   | 12.8            | 36.2    | 9.7 U     | 6.83 U  | 56.9 J   | 7310    | 0.140   | 5130    | 33.5   | 471  | 32.7   | 10800           | 478      |  |  |  |
| 22-007-SW-2   | 59.3                   | 9.87            | 32.7    | 9.7 U     | 6.83 U  | 13.5 J   | 950     | 0.120 U | 4090    | 28     | 2.51 | 30.7 U | 9980            | 438      |  |  |  |
| 22-007-SW-3   | 2.43                   | 78.1            | 27.3    | 9.7 U     | 6.83 U  | 58.8 J   | 55.7    | 0.120 U | 982     | 27.8   | 3.26 | 30.7 U | 3920            | 162      |  |  |  |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                        |                 |         |           |         |  |         |         |         |        |      |        |                 |          |  |  |  |
| Wet Chemistry   |                        | Results in mg/l |         |           |         |  |         | LEGEND  |         |        |      |        |                 |          |  |  |  |
| FIELD I.D.  | TOTAL DISSOLVED SOLIDS | CHLORIDE        | SULFATE | NO3/NO2-N | CYANIDE |  |         |         |         |        |      |        |                 |          |  |  |  |
| 22-007-GW-1   | 343                    | < 5.0           | 132     | < 0.05    | NR      | SE1 - In stream approx. 300' downgradient of tailings pond 4.<br>SE2 - Between tailings and waste rock at road.<br>TP1 - Composite of subsamples TP1A-A through 1A-C, 2A-A through 2A-D, and 3A-A through 3A-C.<br>TP2 - Composite of subsamples TP4A-A through 4A-C, and 4B-C.<br>WR1 - Composite of subsamples WR1A, 1B, and 2A through 2C.<br>WR2 - Composite of subsamples WR3A, 3B, and 4.<br>TP2DUP - Duplicate of the 22-007-TP-2 sample.<br>BACKGROUND - From the Bertha Mine (22-002-SS-1). |         |         |         |        |      |        |                 |          | GW1 - Discharge from adit #1.              |  |  |
| 22-007-GW-2   | 512                    | < 5.0           | 318     | < 0.05    | NR      |  |         |         |         |        |      |        |                 |          | GW2 - Discharge from adit #2.              |  |  |
| 22-007-SW-1   | 776                    | 5.0             | 498     | < 0.05    | NR      |  |         |         |         |        |      |        |                 |          | SW1 - Same as sample SE1.                  |  |  |
| 22-007-SW-2   | 712                    | < 5.0           | 1140    | < 0.05    | NR      |  |         |         |         |        |      |        |                 |          | SW2 - Same as sample SE2.                  |  |  |
| 22-007-SW-3   | 325                    | < 5.0           | 193     | < 0.05    | NR      |  |         |         |         |        |      |        |                 |          | SW3 - Upgradient of site approx. 200 feet. |  |  |



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Argentine</u>  | County: <u>Jefferson</u>                           |
| Legal Description: <u>T 7N R 5W</u>   | Section(s): <u>SW 1/4, NW 1/4, Sec. 2</u>          |
| Mining District: <u>Colorado</u>  | Mine Type: <u>Hardrock/Unknown</u>                 |
| Latitude: <u>N 46° 23' 20"</u>  | Primary Drainage: <u>Clancy Creek</u>              |
| Longitude: <u>W 112° 11' 53"</u>  | USGS Code: <u>10030101</u>                         |
| Land Status: <u>Private/Public</u>  | Secondary Drainage: <u>South Fork Quartz Creek</u> |
| Quad: <u>Chessman Reservoir</u>   | Date Investigated: <u>August 16, 1993</u>          |
| Inspectors: <u>Bullock, Belanger, Pierson</u>   | P.A. # <u>22-102</u>                               |
| Organization: <u>Pioneer Technical Services, Inc./ Thomas, Dean and Hoskins, Inc.</u> |  |

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be approximately 26,000 cubic yards. The following elements were elevated at least three times background:

|                           |                           |
|---------------------------|---------------------------|
| Arsenic: 259J mg/kg       | Manganese: 2540 mg/kg     |
| Lead: 785J to 7640J mg/kg | Zinc: 610J to 1490J mg/kg |
- Three of the adits had minor discharges, although only the adit associated with WR-2 had significant flow. Water samples were collected from this adit (GW-2) and from the adit associated with WR-1 (GW-1). The MCL/MCLG for cadmium was exceeded in GW-1. Acute aquatic life criteria were exceeded for iron, cadmium, copper, lead and zinc in GW-1, and for iron and zinc in GW-2. Chronic aquatic life criteria were exceeded for cadmium, copper, lead, and zinc in GW-1 and for zinc in GW-2.
- An unnamed tributary to the South Fork of Spring Creek bisects the site. Vegetative buffer strips were present between the stream and the waste rock dumps. Observed releases were documented for manganese, lead, and zinc. There were no MCLs or MCLGs exceeded; however, acute and chronic aquatic life criteria were exceeded for zinc and were directly attributable to the site.



**Argentine PA# 22-102**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/16/93**

| SOLID MATRIX ANALYSES   |                |                                |                          |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
|---|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|------------|------------|------------|------------|-----------------|
| Metals in soils<br>Results per dry weight basis   |                |                                |                          |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
| FIELD ID  | As (mg/Kg)     | Ba (mg/Kg)                     | Cd (mg/Kg)               | Co (mg/Kg)                       | Cr (mg/Kg)       | Cu (mg/Kg)       | Fe (mg/Kg)       | Hg (mg/Kg)                       | Mn (mg/Kg)                       | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 22-102-SE-1   | 27             | 41.8                           | 3.4 J                    | 4.1                              | 3.5              | 34.7             | 9900             | 0.04 U                           | 2620                             | 3          | 449        | 7 U        | 439        | NR              |
| 22-102-SE-2   | 6 U            | 13.8                           | 0.7 U                    | 2.5 U                            | 3.4              | 3.4              | 5790             | 0.037 U                          | 146                              | 3 U        | 35         | 8 U        | 30         | NR              |
| 22-102-WR-1   | 55.6 J         | 72.7 J                         | 2.6 J                    | 8.94                             | 6.89             | 97.3             | 23000            | 0.032 U                          | 2540                             | 6.69       | 785 J      | 7.54 U     | 610 J      | NR              |
| 22-102-WR-2   | 259 J          | 22.6 J                         | 8.6 J                    | 3.16                             | 1.47             | 231              | 23300            | 0.056                            | 877                              | 2.41 U     | 7640 J     | 5.84 U     | 1490 J     | NR              |
| BACKGROUND  | 88             | 76                             | 0.7 U                    | 9.5                              | 10.9 J           | 49.7 J           | 20400            | 0.107 J                          | 654 J                            | 9          | 117 JX     | 8 UJ       | 104        | NR              |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                |                                |                          |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
| Acid/Base Accounting  |                |                                |                          |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
| FIELD ID  | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |            |            |            |            |                 |
| 22-102-WR-1   | 0.15           | 4.69                           | 4.99                     | 0.3                              | 0.03             | 0.04             | 0.08             | 1.25                             | 3.74                             |            |            |            |            |                 |
| 22-102-WR-2   | 2.43           | 75.9                           | -7.2                     | -83                              | 1.35             | 0.76             | 0.32             | 23.7                             | -30.9                            |            |            |            |            |                 |

| WATER MATRIX ANALYSES   |                        |          |         |           |         |      |        |         |         |        |      |        |                 |                |
|---|------------------------|----------|---------|-----------|---------|------|--------|---------|---------|--------|------|--------|-----------------|----------------|
| Metals in Water<br>Results in ug/L  |                        |          |         |           |         |      |        |         |         |        |      |        |                 |                |
| FIELD ID  | As                     | Ba       | Cd      | Co        | Cr      | Cu   | Fe     | Hg      | Mn      | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
| 22-102-GW-1   | 1.49 U                 | 2.01 U   | 7.63    | 9.7 U     | 6.83 U  | 26.5 | 1050 J | 0.190 J | 3110 JX | 12.7 U | 106  | 30.7 U | 729             | 19.2           |
| 22-102-GW-2   | 1.49 U                 | 16.7     | 2.57 U  | 9.7 U     | 6.83 U  | 3.27 | 3190 J | 0.120 J | 9110 JX | 13.8   | 4.36 | 30.7 U | 3990            | 415            |
| 22-102-SW-1   | 3.15                   | 5.33     | 2.77    | 9.7 U     | 6.83 U  | 7.67 | 138 J  | 0.140 J | 1600 JX | 12.7 U | 17   | 30.7 U | 385             | 41.4           |
| 22-102-SW-2   | 2.18                   | 4.8      | 2.57 U  | 9.7 U     | 6.83 U  | 2.47 | 66.5 J | 0.118 U | 7.5 JX  | 14.5   | 1.97 | 30.7 U | 8.83            | 28.9           |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                        |          |         |           |         |      |        |         |         |        |      |        |                 |                |
| Wet Chemistry<br>Results in mg/l  |                        |          |         |           |         |      |        |         |         |        |      |        |                 |                |
| FIELD I.D.  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |      |        |         |         |        |      |        |                 |                |
| 22-102-GW-1   | 79                     | < 5.0    | 24      | < 0.05    | NR      |      |        |         |         |        |      |        |                 |                |
| 22-102-GW-2   | 643                    | < 5.0    | 338     | < 0.05    | NR      |      |        |         |         |        |      |        |                 |                |
| 22-102-SW-1   | 102                    | < 5.0    | 22      | < 0.05    | NR      |      |        |         |         |        |      |        |                 |                |
| 22-102-SW-2   | 72                     | < 5.0    | 6       | < 0.05    | NR      |      |        |         |         |        |      |        |                 |                |

**LEGEND**

SE1 - Downgradient of site.  
 SE2 - Upgradient of site.  
 WR1 - Composite of subsamples WR1B, 1C, and 2B.  
 WR2 - Composite of subsamples WR1A and 2A.  
 BACKGROUND - From the Enterprise Mine (22-074-S3-1).

GW1 - Associated with waste rock dump 1.  
 GW2 - Associated with waste rock dump 3.  
 SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Minah  
Legal Description: T 7N R 4W  
Mining District: Colorado  
Latitude: N 46° 21' 53"  
Longitude: W 112° 08' 16"  
Land Status: Private  
Quad: Mount Thompson  
Inspectors: Babits, Lasher/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Jefferson  
Section(s): SW 1/4, SW 1/4, Sec. 17  
Mine Type: Hardrock/Au, Ag, Cu, Pb, Zn  
Primary Drainage: Prickly Pear Creek  
USGS Code: 10030101  
Secondary Drainage: Spring Creek  
Date Investigated: July 9, 1993  
P.A. # 22-104

- The Minah Mine became part of the Montana Tunnels project in 1989. All features of the Minah Mine have been obliterated; consequently, no samples were collected during the investigation.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |   |
|--|---|
| Mine/Site Name: <u>Wickes Smelter</u>  | County: <u>Jefferson</u>                    |
| Legal Description: T <u>7N</u> R <u>4W</u>   | Section(s): <u>SW 1/4, SW 1/4, Sec. 15</u>  |
| Mining District: <u>Colorado</u>   | Mine Type: <u>Smelter/Cu, Zn, Pb</u>        |
| Latitude: <u>N 46° 21' 06"</u>   | Primary Drainage: <u>Spring Creek</u>       |
| Longitude: <u>W 112° 06' 01"</u>   | USGS Code: <u>10030101</u>                  |
| Land Status: <u>Private</u>  | Secondary Drainage: <u>Finn Gulch Creek</u> |
| Quad: <u>Wickes</u>  | Date Investigated: <u>August 17, 1993</u>   |
| Inspectors: <u>Bullock, Belanger, Pierson</u>  | P.A. # <u>22-358</u>                        |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |   |

- Contaminant sources at this site were associated with historic smelting activities and included possible kiln dust, clinker, and slag. The volume of waste material associated with this site was roughly estimated at 2000 to 4000 cubic yards. The following elements were elevated at least three times background:

|                             |                                |
|-----------------------------|--------------------------------|
| Arsenic: 613J to 4290J mg/l | Cadmium: 26.6J mg/kg           |
| Mercury: 3.18 to 20.9 mg/kg | Lead: 9400J to 31,700J mg/kg   |
| Antimony: 20 to 26 mg/kg    | Zinc: 2960JX to 19,000JX mg/kg |
- The high mercury measurement was obtained in a sample of the suspected flue dust material directly north of the stack.
- Finn Gulch, a small intermittent tributary to Spring Creek, bisects the site. The drainage was dry at the time of this investigation. Sediment samples were collected up and down gradient of the site. An observed release of mercury to this drainage was documented.
- The town of Wickes was adjacent to this site. Direct contact hazards were considered significant, especially with regard to small children .



**Wickes Tailings PA# 22-358**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/17/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 22-358-SE-1 | 77 J       | 38.9 J     | 1.5 J      | 3.7 J      | 4 J        | 188 JX     | 11200 J    | 4.8        | 354 J      | 4 J        | 700 J      | 5 U        | 384 JX     | NR              |
| 22-358-SE-2 | 33 J       | 66.4 J     | 0.5 U      | 6.9 J      | 5 J        | 237 JX     | 16800 J    | 0.035 U    | 574 J      | 8 J        | 344 J      | 6 U        | 256 JX     | NR              |
| 22-358-WR-1 | 613 J      | 67.9 J     | 15.7 J     | 18.9 J     | 5.7 J      | 6450 JX    | 65400 J    | 3.18       | 2940 J     | 8 J        | 25600 J    | 20         | 19000 JX   | NR              |
| 22-358-WR-2 | 789 J      | 109 J      | 8.7 J      | 10.4 J     | 9.6 J      | 2370 JX    | 31900 J    | 20.9       | 1020 J     | 6 J        | 9400 J     | 26         | 6040 JX    | NR              |
| 22-358-WR-3 | 4290 J     | 25.9 J     | 26.6 J     | 4.4 J      | 5.9 J      | 3780 JX    | 33500 J    | 35.2       | 467 J      | 3 J        | 31700 J    | 22         | 2960 JX    | NR              |
| BACKGROUND  | 187 J      | 92.1       | 6.6        | 11.4       | 8.4 J      | 232 J      | 31600      | 0.029      | 1040       | 11 J       | 447 J      | 6 UJ       | 618        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 22-358-WR-1 | 1.82           | 56.9                           | -6.5                    | -63                              | 0.47             | 0.46             | 0.89             | 14.4                             | -20.8                            |
| 22-358-WR-2 | 0.77           | 24.1                           | 5.91                    | -18                              | 0.44             | 0.07             | 0.26             | 2.19                             | 3.72                             |
| 22-358-WR-3 | 2.38           | 74.4                           | 2.48                    | -72                              | 1.8              | 0.15             | 0.43             | 4.69                             | -2.21                            |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba     | Cd     | Co    | Cr     | Cu     | Fe   | Hg     | Mn   | Ni     | Pb   | Sb     | HARDNESS CALC. Zn (mg CaCO3/L) |
|-------------|--------|--------|--------|-------|--------|--------|------|--------|------|--------|------|--------|--------------------------------|
| 22-358-GW-1 | 0.96 U | 2.01 U | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 37.8 | 0.18 J | 18.2 | 12.7 U | 1.13 | 30.7 U | 15.9 0.2                       |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**LEGEND**

SE1 - Downgradient of site.  
SE2 - Upgradient of site.  
WR1 - Sample from the WR4 subsample.  
WR2 - Sample from the WR2 subsample.  
WR3 - Sample from the WR1 subsample.  
BACKGROUND - From the Bertha Mine (22-002-SS-1).  
GW1 - QA/QC Blank.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Elkhorn Queen</u>                  | County: <u>Jefferson</u>                      |
| Legal Description: <u>T 6N R 3W</u>                   | Section(s): <u>SE 1/4, NW 1/4, Sec. 26</u>    |
| Mining District: <u>Elkhorn</u>                       | Mine Type: <u>Hardrock/Au, Ag, Pb, Zn, Cu</u> |
| Latitude: <u>N 46° 14' 46"</u>                        | Primary Drainage: <u>Elkhorn Creek</u>        |
| Longitude: <u>W 111° 56' 42"</u>                      | USGS Code: <u>10020006</u>                    |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>South Fork Queen</u>   |
| Quad: <u>Tacoma Park</u>                              | <u>Gulch</u>                                  |
| Inspectors: <u>Babits, Flammang, Lasher</u>           | Date Investigated: <u>August 16, 1993</u>     |
| Organization: <u>Pioneer Technical Services, Inc.</u> | P.A. # <u>22-027</u>                          |

- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 23,000 cubic yards. The following elements were elevated at least three times background:

|                        |                       |
|------------------------|-----------------------|
| Arsenic: 10,100J mg/kg | Cadmium: 405J mg/kg   |
| Cobalt: 28.4 mg/kg     | Iron: 112,000 mg/kg   |
| Mercury: 0.441 mg/kg   | Nickel :19.1 mg/kg    |
| Lead: 40,200J mg/kg    | Antimony: 64.6J mg/kg |
| Zinc: 20,000J mg/kg    |                       |
- There were no discharging adits, filled shafts, seeps, or springs identified at the site during the investigation.
- The South Fork of Queen Gulch was the nearest surface water to the site, which was located approximately 1,000 feet to the north. No surface water or sediment samples were collected due to the lack of a direct runoff route.
- Potential safety hazards identified at the site included an open shaft (with a headframe and loadout structure) and an open adit .

**Elkhorn Queen PA# 22-027**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/16/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 22-027-WR-1 | 10100 J       | 118 J         | 405 J         | 28.4          | 2.38          | 87.6          | 112000        | 0.441         | 2590          | 19.1          | 40200 J       | 64.6 J        | 20000 J       | NR                 |
| BACKGROUND  | 29.8 J        | 255 J         | 1.1 J         | 7.47          | 5.79          | 31.7          | 19700         | 0.039         | 1170          | 6.23          | 38.2 J        | 5.89 U        | 101 J         | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL.<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|--------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 22-027-WR-1 | 4.24              | 132                                  | 38.0                           | -94.4                                     | <0.01                  | 3.08                   | 2.06                   | 96.2                                      | -58.2                                     |

**LEGEND**

WR1 - Composite of subsamples WR1A, 1B, and 1C.  
BACKGROUND - From Tacoma (22-284-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Queen/Tourmaline Queen</u>         | County: <u>Jefferson</u>                   |
| Legal Description: T <u>6N</u> R <u>3W</u>            | Section(s): <u>SW 1/4, NE 1/4, Sec. 22</u> |
| Mining District: <u>Elkhorn</u>                       | Mine Type: <u>Hardrock/Au</u>              |
| Latitude: <u>N 46° 15' 00"</u>                        | Primary Drainage: <u>Boulder River</u>     |
| Longitude: <u>W 111° 57' 00"</u>                      | USGS Code: <u>10020006</u>                 |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Elkhorn Creek</u>   |
| Quad: <u>Elkhorn</u>                                  | Date Investigated: <u>August 16, 1993</u>  |
| Inspectors: <u>Babits, Flammang, Lasher</u>           | P.A. # <u>22-111</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 80,000 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 1,420J mg/kg      Iron: 87,600 mg/kg
- No discharging adits, filled shafts, seeps, or springs were identified at the site during the investigation.
- Elkhorn Creek was flowing approximately 20 feet from the toe of WR-1. Surface water and sediment samples were collected upstream and downstream from the site. Chronic aquatic life criteria were exceeded for mercury and lead in both the upstream and downstream samples. Contaminant concentrations were not elevated in the downstream samples (surface water or sediment) when compared to the upstream samples.
- No hazardous mine openings or structures were identified at the site.



**Queen PA# 22-111**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/16/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 22-111-SE-1 | 156 J      | 37 J       | 45.1 J     | 4.17       | 9.32       | 279        | 14700      | 23.4       | 1570       | 5.36       | 2010 J     | 110 J      | 6880 J     | NR              |
| 22-111-SE-2 | 140 J      | 17.8 J     | 36.3 J     | 2.47 U     | 6.29       | 212        | 14400      | 14.6       | 1050       | 4.81       | 1800 J     | 103 J      | 6140 J     | NR              |
| 22-111-WR-1 | 1420 J     | 37.4 J     | 1.2 J      | 14.3       | 12.5       | 33.4       | 87600      | 0.032 U    | 395        | 5.93       | 73.4 J     | 4.73 U     | 167 J      | NR              |
| BACKGROUND  | 29.8 J     | 255 J      | 1.1 J      | 7.47       | 5.79       | 31.7       | 19700      | 0.039      | 1170       | 6.23       | 38.2 J     | 5.89 U     | 101 J      | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 22-111-WR-1 | 0.47           | 14.7                           | 1.90                    | -12.8                            | 0.38             | <0.01            | 0.09             | 0.00                             | 1.90                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co    | Cr     | Cu     | Fe  | Hg     | Mn   | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|------|--------|-------|--------|--------|-----|--------|------|--------|------|--------|-----------------|----------------|
| 22-111-SW-1 | 3.42 | 10.6 | 2.57 U | 9.7 U | 6.83 U | 5.77 J | 300 | 0.44 J | 21.5 | 12.7 U | 22.8 | 30.7 U | 65.2            | 62.7           |
| 22-111-SW-2 | 4.39 | 11.1 | 2.57 U | 9.7 U | 6.83 U | 4.03 J | 262 | 0.36 J | 18.9 | 12.7 U | 21.7 | 30.7 U | 58.4            | 61.9           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 22-111-SW-1 | 108                    | < 5.0    | 10      | < 0.05    | NR      |
| 22-111-SW-2 | 114                    | < 5.0    | 10      | 0.08      | NR      |

**LEGEND**

SE1 - Upstream on Elkhorn Creek.  
SE2 - Downstream on Elkhorn Creek.  
WR1 - Composite of subsamples WR1A, 1B, and 1C.  
BACKGROUND - From Tacoma (22-284-SS-1).

SW1 - Same as SE1.  
SW2 - Same as SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Tacoma</u>                         | County: <u>Jefferson</u>                   |
| Legal Description: T <u>6N</u> R <u>3W</u>            | Section(s): <u>NW 1/4, NE 1/4, Sec. 34</u> |
| Mining District: <u>Elkhorn</u>                       | Mine Type: <u>Hardrock/Au, Ag, Pb</u>      |
| Latitude: <u>N 46° 13' 58"</u>                        | Primary Drainage: <u>Elkhorn Creek</u>     |
| Longitude: <u>W 111° 57' 47"</u>                      | USGS Code: <u>10020006</u>                 |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Tacoma Gulch</u>    |
| Quad: <u>Tacoma Park</u>                              | Date Investigated: <u>August 16, 1993</u>  |
| Inspectors: <u>Babits, Flammang, Lasher</u>           | P.A. # <u>22-284</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 7,320 cubic yards. The following elements were elevated at least three times background:

|                               |                               |
|-------------------------------|-------------------------------|
| Arsenic: 177J mg/kg           | Cadmium: 3.9 J to 12J mg/kg   |
| Mercury: 0.175 to 0.507 mg/kg | Lead: 1,320J to 23,600J mg/kg |
| Zinc: 859J to 1,530J mg/kg    |                               |
- No discharging adits, filled shafts, seeps, or springs were identified at the site.
- An unnamed, minor, intermittent drainage (dry at the time of the investigation) was situated through the center of the site; however, no sediment samples were collected.
- Seven potentially hazardous open (or partially open) adits were identified at the site.

**Tacoma PA# 22-284**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/16/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 22-284-WR-1 | 177 J         | 168 J         | 12.0 J        | 6.97          | 1.39 U        | 334           | 30200         | 0.507         | 900           | 2.66          | 23600 J       | 6.34 J        | 1530 J        | NR                 |
| 22-284-WR-2 | 35.2 J        | 158 J         | 3.9 J         | 7.67          | 2.09          | 25.4          | 19100         | 0.175         | 835           | 2.66 U        | 1320 J        | 6.45 U        | 859 J         | NR                 |
| BACKGROUND  | 29.8 J        | 255 J         | 1.1 J         | 7.47          | 5.79          | 31.7          | 19700         | 0.039         | 1170          | 6.23          | 38.2 J        | 5.89 U        | 101 J         | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|----------------------|---|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 22-284-WR-1 | 0.03                 | 0.94                                    | 14.3                          | 13.3                                      | 0.02                   | <0.01                  | 0.01                   | 0.00                                      | 14.3                                      |
| 22-284-WR-2 | 0.01                 | 0.31                                    | 42.8                          | 42.5                                      | <0.01                  | <0.01                  | 0.01                   | 0.00                                      | 42.8                                      |

**LEGEND**

WR1 - Composite of subsamples WR1, 2A, 2B, 5, and 6.  
WR2 - Composite of subsamples WR7, 8, and 9.  
BACKGROUND - From Tacoma (22-284-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Sourdough  
Legal Description: T 6N R 3W  
Mining District: Elkhorn  
Latitude: N 46° 17' 00"  
Longitude: W 111° 57' 37"  
Land Status: Private/Public  
Quad: Elkhorn  
Inspectors: Babits, Flammang, Lasher  
Organization: Pioneer Technical Services, Inc.

County: Jefferson  
Section(s): NW 1/4, SE 1/4, Sec. 10  
Mine Type: Hardrock/Fe, Au  
Primary Drainage: Elkhorn Creek  
USGS Code: 10020006  
Secondary Drainage: Greyback Gulch  
Date Investigated: August 20, 1993  
P.A. # 22-336

- There were no tailings on site.
- There were approximately 34,250 cubic yards of uncovered waste rock on site. The following were elevated at least three times background:  
Arsenic: 105 to 560 mg/kg                      Copper: 336 to 750 mg/kg  
Mercury: 0.848 mg/kg
- There was a discharging adit on site and it did not enter the creek by a surface route. The sample had a pH of 6.56. Cadmium exceeded the MCL/MCLG.
- The creek ran adjacent to waste rock. There was an observed release of copper in downstream surface water. No MCL/MCLGs were exceeded in downstream surface water. The chronic aquatic life criteria for lead was exceeded in downstream surface water, which was directly attributable to the site.
- There were five open adits and one highwall on site.



**Sourdough PA# 22-336**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/20/93**

| SOLID MATRIX ANALYSES   |                |                                |                         |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
|---|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|------------|------------|------------|------------|-----------------|
| Metals in soils<br>Results per dry weight basis   |                |                                |                         |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
| FIELD ID  | As (mg/Kg)     | Ba (mg/Kg)                     | Cd (mg/Kg)              | Co (mg/Kg)                       | Cr (mg/Kg)       | Cu (mg/Kg)       | Fe (mg/Kg)       | Hg (mg/Kg)                       | Mn (mg/Kg)                       | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 22-336-SE-1   | 5.72 U         | 14.9                           | 1.1 UJ                  | 2.01 J                           | 11.9 J           | 7.9              | 6070             | 0.062                            | 148                              | 5.37 J     | 7.84 U     | 7.56 U     | 11.8       | NR              |
| 22-336-SE-2   | 46.2           | 72.4                           | 1.1 UJ                  | 13.3 J                           | 36.3 J           | 203              | 20000            | 0.104                            | 606                              | 19.6 J     | 16.8       | 7.58 U     | 72.3       | NR              |
| 22-336-WR-1   | 560            | 25.1                           | 0.8 UJ                  | 14.6 J                           | 5.76 J           | 750              | 13500            | 0.044                            | 1030                             | 12.9 J     | 36.2       | 5.69 U     | 249        | NR              |
| 22-336-WR-2   | 535            | 29.9                           | 1.0 UJ                  | 18.3 J                           | 7.18 J           | 701              | 51800            | 0.056                            | 770                              | 6.54 J     | 70.6       | 6.57 U     | 126        | NR              |
| 22-336-WR-3   | 105            | 29.3                           | 0.7 UJ                  | 15.3 J                           | 13.8 J           | 336              | 24900            | 0.848                            | 640                              | 14 J       | 32.7       | 4.96 U     | 173        | NR              |
| BACKGROUND  | 76.1           | 157                            | 0.7 UJ                  | 15.5 J                           | 55.6 J           | 64.1             | 24500            | 0.118                            | 1260                             | 33.5 J     | 86.7       | 4.86 U     | 121        | NR              |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                |                                |                         |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
| Acid/Base Accounting  |                |                                |                         |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
| FIELD ID  | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |            |            |            |            |                 |
| 22-336-WR-1   | 0.02           | 0.62                           | 79.8                    | 79.2                             | <0.01            | 0.01             | 0.02             | 0.31                             | 79.5                             |            |            |            |            |                 |
| 22-336-WR-2   | 0.56           | 17.5                           | 13.9                    | -3.6                             | 0.38             | 0.06             | 0.12             | 1.87                             | 12                               |            |            |            |            |                 |
| 22-336-WR-3   | 0.05           | 1.56                           | 31.9                    | 30.3                             | 0.01             | <0.01            | 0.04             | 0                                | 31.9                             |            |            |            |            |                 |

| WATER MATRIX ANALYSES   |                        |          |         |           |         |        |         |        |      |        |        |        |        |                             |
|---|------------------------|----------|---------|-----------|---------|--------|---------|--------|------|--------|--------|--------|--------|-----------------------------|
| Metals in Water<br>Results in ug/L  |                        |          |         |           |         |        |         |        |      |        |        |        |        |                             |
| FIELD ID  | As                     | Ba       | Cd      | Co        | Cr      | Cu     | Fe      | Hg     | Mn   | Ni     | Pb     | Sb     | Zn     | HARDNESS CALC. (mg CaCO3/L) |
| 22-336-SW-1   | 3.33 J                 | 5        | 2.57 U  | 9.7 U     | 6.83 U  | 1.55 U | 50.3 J  | 0.12 U | 8.77 | 12.7 U | 1.55 U | 30.7 U | 7.57 U | 65.4                        |
| 22-336-SW-2   | 2.47 J                 | 5.87     | 2.57 U  | 9.7 U     | 8.73 J  | 6.5 J  | 145 J   | 0.12 U | 11.7 | 12.7 U | 2.24   | 30.7 U | 7.57 U | 70.4                        |
| 22-336-SW-3   | 8.82 J                 | 2.01 U   | 8.6     | 148       | 6.83 U  | 1120 J | 34000 J | 0.12 U | 7460 | 35.4   | 1.55 U | 30.7 U | 429    | 470                         |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                        |          |         |           |         |        |         |        |      |        |        |        |        |                             |
| Wet Chemistry<br>Results in mg/l  |                        |          |         |           |         |        |         |        |      |        |        |        |        |                             |
| FIELD ID  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |        |         |        |      |        |        |        |        |                             |
| 22-336-SW-1   | 99                     | < 5.0    | 11      | < 0.05    | NR      |        |         |        |      |        |        |        |        |                             |
| 22-336-SW-2   | 80                     | < 5.0    | 7       | < 0.05    | NR      |        |         |        |      |        |        |        |        |                             |
| 22-336-SW-3   | 684                    | < 5.0    | 467     | 0.31      | NR      |        |         |        |      |        |        |        |        |                             |

**LEGEND**

SE1 - Upgradient approx. 300' from waste rock dump 4.  
SE2 - Downgradient approx. 50' from base of waste rock dump 5.  
WR1 - Composite of subsamples WR2, 3A, and 3B.  
WR2 - Composite of subsamples WR4A, 4B, 4C, and 4D.  
WR3 - Composite of subsamples WR5A, 5B, and 5C.  
BACKGROUND - North side of Greyback Creek.  
From Sourdough Mine (22-336-SS-1).  
SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.  
SW3 - Adit discharge of waste rock dump 5.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Comet</u>                          | County: <u>Jefferson</u>                      |
| Legal Description: <u>T 7N R 5W</u>                   | Section(s): <u>S 1/2, Sec. 36</u>             |
| Mining District: <u>Basin/High Ore</u>                | Mine Type: <u>Hardrock/Au, Ag, Cu, Pb, Zn</u> |
| Latitude: <u>N 46° 18' 37"</u>                        | Primary Drainage: <u>Boulder River</u>        |
| Longitude: <u>W 112° 10' 02"</u>                      | USGS Code: <u>10020006</u>                    |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>High Ore Creek</u>     |
| Quad: <u>Mount Thompson</u>                           | Date Investigated: <u>July 8, 1993</u>        |
| Inspectors: <u>Bullock, Belanger, Clark</u>           | P.A. # <u>22-009</u>                          |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- The past reclamation project involving stream diversion and settling pond construction was in need of repair and maintenance. The diversion ditch was at risk of failure and the upper settling pond was at full capacity and ineffective.
- The volume of tailings associated with this site was estimated to be approximately 500,000 cubic yards. The following elements were elevated at least three times background:

|                               |                              |
|-------------------------------|------------------------------|
| Arsenic: 3400 to 4790 mg/kg   | Cadmium: 13.0 to 20.1 mg/kg  |
| Copper: 324J to 445J mg/kg    | Iron: 33,900 to 39,700 mg/kg |
| Mercury: 0.338 to 0.975 mg/kg | Lead: 2330 to 4420 mg/kg     |
| Antimony: 14 to 31 mg/kg      | Zinc: 1900J to 3020J mg/kg   |
| Manganese: 5860 to 8550 mg/kg |                              |
- The lower tailings impoundment (TP2) was breached and actively eroding.
- The volume of waste rock associated with this site was estimated to be approximately 214,000 cubic yards. The following elements are elevated at least three times background:

|                              |                               |
|------------------------------|-------------------------------|
| Arsenic: 1260 to 1610 mg/kg  | Cadmium: 23.6 to 36.4 mg/kg   |
| Copper: 245J to 248J mg/kg   | Manganese: 3930 to 6100 mg/kg |
| Mercury: 0.543 to 1.59 mg/kg | Lead: 2590 to 3750 mg/kg      |
| Antimony: 25 mg/kg           | Zinc: 3720J to 6060J mg/kg    |
- High Ore Creek had been diverted around most of the site, although diversion leakage, groundwater discharge, and runoff was still transporting contaminants to the creek. Observed releases to High Ore Creek were documented for arsenic, cadmium, copper, manganese, lead, and zinc; and MCLs for arsenic and cadmium were exceeded in the downstream sample. The acute aquatic life criteria was exceeded for zinc and the chronic aquatic life criteria for copper and zinc were exceeded; directly attributable to the site. Water pH in the stream remains above neutral as the stream flows through the impacted area.

**Comet Tailings PA# 22-009**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/08/93**

| SOLID MATRIX ANALYSES   |                 |               |                              |               |               |               |               |               |               |               |               |               |               |                    |
|---|-----------------|---------------|------------------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| FIELD ID  | Metals in soils |               | Results per dry weight basis |               |               |               |               |               |               |               |               |               |               |                    |
|   | As<br>(mg/Kg)   | Ba<br>(mg/Kg) | Cd<br>(mg/Kg)                | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
| 22-009-SE-1   | 1670            | 150           | 19.3                         | 17.4          | 4.7           | 224 J         | 18300         | 0.330         | 6060          | 4 J           | 1560          | 16            | 3670 J        | NR                 |
| 22-009-SE-2   | 25              | 120           | 1.2                          | 5.3           | 8.7           | 7.8 J         | 11300         | 0.025         | 992           | 6 J           | 33            | 8 U           | 62 J          | NR                 |
| 22-009-TP-1   | 4790            | 224           | 17.7                         | 16.1          | 1.8           | 324 J         | 39700         | 0.338         | 5860          | 6 J           | 1530          | 14            | 3010 J        | NR                 |
| 22-009-TP-2   | 4640            | 205           | 13.0                         | 10.8          | 3.3           | 434 J         | 33900         | 0.975         | 7440          | 3 J           | 2610          | 26            | 1900 J        | NR                 |
| 22-009-TP-3   | 3400            | 239           | 20.1                         | 12.6          | 3.3           | 445 J         | 32500         | 0.674         | 8550          | 2 U           | 2270          | 31            | 3020 J        | NR                 |
| 22-009-WR-1   | 1610            | 153           | 36.4                         | 8.1           | 1.6           | 248 J         | 24500         | 1.59          | 3930          | 4 J           | 3750          | 13            | 6060 J        | NR                 |
| 22-009-WR-2   | 1260            | 65.0          | 23.6                         | 5.0           | 1.5           | 245 J         | 23100         | 0.543         | 6100          | 3 U           | 2590          | 25            | 3720 J        | NR                 |
| BACKGROUND  | 137             | 265           | 3.0                          | 6.7           | 4.6           | 35.9 J        | 12100         | 0.019         | 1280          | 6 J           | 84            | 7 U           | 227 J         | NR                 |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                 |               |                              |               |               |               |               |               |               |               |               |               |               |                    |
| Acid/Base Accounting  |                 |               |                              |               |               |               |               |               |               |               |               |               |               |                    |
| FIELD ID  | TOTAL           | TOTAL         | NEUTRAL.                     | SULFUR        | SULFATE       | PYRITIC       | ORGANIC       | PYRITIC       | SULFUR        |               |               |               |               |                    |
|   | SULFUR          | SULFUR        | POTENT.                      | ACID BASE     | SULFUR        | SULFUR        | SULFUR        | SULFUR        | ACID BASE     | ACID BASE     | POTENT.       |               |               |                    |
|   | %               | 1/1000t       | 1/1000t                      | 1/1000t       | %             | %             | %             | 1/1000t       | 1/1000t       |               |               |               |               |                    |
| 22-009-SS-1DUP  | 0.02            | 0.62          | 7.23                         | 6.61          | <0.01         | 0.01          | 0.01          | 0.31          | 6.92          |               |               |               |               |                    |
| 22-009-SS-1   | 0.02            | 0.62          | 7.41                         | 6.78          | 0.01          | <0.01         | 0.01          | 0             | 7.41          |               |               |               |               |                    |
| 22-009-TP-1   | 2.96            | 92.5          | 146                          | 53.8          | <0.01         | 3.47          | 0.38          | 108           | 37.9          |               |               |               |               |                    |
| 22-009-TP-2   | 1.92            | 60            | 79.7                         | 19.7          | 0.4           | 1.34          | 0.18          | 14.9          | 37.8          |               |               |               |               |                    |
| 22-009-TP-3   | 1.84            | 57.5          | 104                          | 46.6          | 0.63          | 0.99          | 0.22          | 30.9          | 73.2          |               |               |               |               |                    |
| 22-009-WR-1   | 1.18            | 36.9          | 41.1                         | 4.22          | 0.57          | 0.37          | 0.24          | 11.6          | 29.5          |               |               |               |               |                    |
| 22-009-WR-2   | 1.6             | 50            | 45.3                         | -4.7          | 0.39          | 0.52          | 0.69          | 16.2          | 29.1          |               |               |               |               |                    |

| WATER MATRIX ANALYSES |        |                 |        |       |        |        |      |         |      |        |        |        |                                      |      |
|-----------------------|--------|-----------------|--------|-------|--------|--------|------|---------|------|--------|--------|--------|--------------------------------------|------|
| Metals in Water       |        | Results in ug/L |        |       |        |        |      |         |      |        |        |        |                                      |      |
| FIELD ID              | As     | Ba              | Cd     | Co    | Cr     | Cu     | Fe   | Hg      | Mn   | Ni     | Pb     | Sb     | HARDNESS<br>CALC.<br>Zn (mg CaCO3/L) |      |
| 22-009-GW-1           | 13.4 J | 44.4            | 7.87   | 9.7 U | 6.83 U | 57 J   | 39.9 | 0.038 U | 455  | 12.7 U | 6.51 J | 30.7 U | 1870                                 | 286  |
| 22-009-GW-2           | 11 J   | 45.5            | 8.37   | 9.7 U | 6.83 U | 63.2 J | 22.4 | 0.130 J | 440  | 12.7 U | 6.37 J | 30.7 U | 2110                                 | 288  |
| 22-009-SW-1           | 56.7 J | 27              | 7.03   | 9.7 U | 6.83 U | 20.8 J | 429  | 0.042 J | 1240 | 12.7 U | 25.3 J | 30.7 U | 2020                                 | 129  |
| 22-009-SW-2           | 4.19 J | 29.5            | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 209  | 0.038 U | 43.7 | 12.7 U | 7.69 J | 30.7 U | 7.57 U                               | 54.8 |

| Wet Chemistry |                        | Results in mg/l |         |           |         |  |
|---------------|------------------------|-----------------|---------|-----------|---------|--|
| FIELD ID.     | TOTAL DISSOLVED SOLIDS | CHLORIDE        | SULFATE | NO3/NO2-N | CYANIDE |  |
| 22-009-GW-1   | 327                    | < 5.0           | 69      | < 0.05    | NR      |  |
| 22-009-GW-2   | 354                    | < 5.0           | 70      | < 0.05    | NR      |  |
| 22-009-SW-1   | 194                    | < 5.0           | 70      | < 0.05    | NR      |  |
| 22-009-SW-2   | 101                    | < 5.0           | 8       | < 0.05    | NR      |  |

| LEGEND  |  |
|---|--|
| SE1 - Downgradient approx. 0.25 mile from the end of reclaimed stream.    | SS1 - Background sample.               |
| SE2 - Upgradient approx. 300 feet above town.                             | GW1 - Silver Hill shaft #1.            |
| TP1 - Composite of subsamples TP1A-A, -B, -C.                             | GW2 - Duplicate of sample 22-009-GW-1. |
| TP2 - Composite of subsamples TP2A-A, -B, -C, and -D.                     | SW1 - Same as sample SE1.              |
| TP3 - Composite of subsamples TP1B-A, -B, -C, -D, -E, and TP1C-A, -B, -C. | SW2 - Same as sample SE2.              |
| WR1 - Composite of subsamples WR1A, 1B, 1C, 1D, 1E, 2A, 2B, and 2C.       |  |
| WR2 - Composite of subsamples WR3A, 3B, 3C, and 3D.                       |  |
| BACKGROUND - From the Comet Mine (22-009-SS-1).                           |  |



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Grey Eagle</u>                     | County: <u>Jefferson</u>                      |
| Legal Description: T <u>7N</u> R <u>5W</u>            | Section(s): <u>SW 1/4, Sec. 35</u>            |
| Mining District: <u>Basin/High Ore</u>                | Mine Type: <u>Hardrock/Ag, Pb, Cu, Zn, Au</u> |
| Latitude: <u>N 46° 18' 52"</u>                        | Primary Drainage: <u>Boulder River</u>        |
| Longitude: <u>W 112° 12' 00"</u>                      | USGS Code: <u>10020006</u>                    |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Bishop Creek</u>       |
| Quad: <u>Mount Thompson</u>                           | Date Investigated: <u>July 9, 1993</u>        |
| Inspectors: <u>Bullock, Belanger, Clark</u>           | P.A. # <u>22-029</u>                          |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be approximately 73,000 cubic yards. The following elements were elevated at least three times background:

|                   |                       |
|-------------------|-----------------------|
| Copper: 503 mg/kg | Mercury: 0.411J mg/kg |
| Lead: 722 mg/kg   | Zinc: 859 mg/kg       |
- Iron staining emanating from Adit #1 indicated past discharge, although no discharge was occurring at the time of the investigation. The water collected within the adit portal had a pH of 6.98 and a specific conductance of 354 umhos/cm.
- Bishop Creek, a tributary to High Ore Creek, flowed adjacent to the site. Observed releases to Bishop Creek (sediment) were documented for copper, lead, and zinc. No MCLs/MCLGs or aquatic life criteria were exceeded that were directly attributable to the site.



**Grey Eagle PA# 22-029**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/09/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 22-029-SE-1 | 63 JX      | 62.9       | 1.4        | 4.4        | 5.9        | 43.3       | 9470       | 0.013 J    | 817 J      | 4          | 266        | 12 J       | 361        | NR              |
| 22-029-SE-2 | 7 JX       | 57.3       | 0.6 U      | 4.1        | 7.5        | 7.1        | 10500      | 0.01 U     | 557 J      | 5          | 14         | 8 UJ       | 32         | NR              |
| 22-029-WR-1 | 265 JX     | 491        | 4.1        | 7.4        | 1.1 U      | 503        | 13900      | 0.411 J    | 1840 J     | 6          | 722        | 14 J       | 859        | NR              |
| BACKGROUND  | 137        | 265        | 3.0        | 6.7        | 4.6        | 35.9J      | 12100      | 0.019      | 1280       | 6J         | 84         | 7U         | 227J       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 22-029-WR-1 | 1.74           | 54.4                           | 84.2                    | 29.8                             | 0.51             | 0.72             | 0.51             | 22.5                             | 61.7                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu     | Fe    | Hg      | Mn      | Ni     | Pb      | Sb     | HARDNESS CALC. Zn (mg CaCO3/L) |
|-------------|--------|------|--------|-------|--------|--------|-------|---------|---------|--------|---------|--------|--------------------------------|
| 22-029-SW-1 | 2.31   | 22.6 | 2.57 U | 9.7 U | 6.83 U | 4.23 J | 187 J | 0.038 U | 29.6 JX | 12.7 U | 9.68 JX | 30.7 U | 26.8 J 46.4                    |
| 22-029-SW-2 | 1.69 U | 21.9 | 2.57 U | 9.7 U | 6.83 U | 2.9 J  | 159 J | 0.038 U | 16.6 JX | 12.7 U | 5.77 JX | 30.7 U | 13.3 J 32.4                    |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID.   | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 22-029-SW-1 | 129                    | < 5.0    | 17      | < 0.05    | NR      |
| 22-029-SW-2 | 97                     | < 5.0    | 8       | < 0.05    | NR      |

**LEGEND**

SE1 - Downgradient of waste rock dumps on Bishop Creek.  
SE2 - Upgradient of waste rock dumps on Bishop Creek.  
WR1 - Composite of subsamples WR1A through 1D.  
BACKGROUND - From the Comet Tailings (22-009-SS-1).

SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Block "P" Mine  
Legal Description: T 15N R 9E  
Mining District: Hughesville  
Latitude: N 47° 05' 01"  
Longitude: W 110° 37' 56"  
Land Status: Private/Public  
Quad: Barker  
Inspectors: Bullock, Babits, Flammang, Lasher,  
Clark / Pierson  
Organization: Pioneer Technical Services, Inc./  
Thomas, Dean and Hoskins, Inc.

County: Judith Basin  
Section(s): NE 1/4, NW 1/4 Sec. 7  
Mine Type: Hardrock/Pb, Ag, Zn  
Primary Drainage: Dry Fork Belt Creek  
USGS Code: 10030105  
Secondary Drainage: Galena Creek  
Date Investigated: June 7, 1993  
P.A. # 23-001

- There were no mill tailings associated with this site.
- The total volume of waste rock associated with this site was estimated at 125,000 cubic yards. The following elements were elevated at least three times background in previous investigations:

|                             |                             |
|-----------------------------|-----------------------------|
| Arsenic: 299 to 1,030 mg/kg | Copper: 32 to 312 mg/kg     |
| Mercury: 0.20 to 1.40 mg/kg | Lead: 4,050 to 24,600 mg/kg |
- The waste rock was not contained, and was actively eroding into Galena Creek. The waste rock had a very low pH (2.52), was unvegetated, and had very steep sides along Galena Creek.
- One adit was on site; previous investigations estimated flow at 6 gpm, pH was 6.49, and SC was 375 us/cm. One seep was also associated with this site; flow estimated at 1.5 gpm, pH was 3.45, and SC was 1010 us/cm.
- Surface water samples were collected during the 1993 investigation. Observed releases to surface water were documented for arsenic in water, and arsenic, mercury, and lead in sediment samples. Drinking water standards (MCL's) were exceeded for cadmium, lead, and antimony; acute aquatic life criteria exceedances for cadmium, copper, and zinc were also documented. Upstream samples exceeded MCL's for antimony and lead, and acute aquatic life criteria for copper and zinc; the Hughesville mining district was upstream from the site and contributed to the observed upstream water quality degradation.
- Monitoring wells, sampled previously, indicated that MCL's were exceeded for cadmium, copper, nickel, and lead. These samples also documented an observed release to groundwater for copper and lead. The upgradient well exceeded MCL's for arsenic, cadmium, and nickel, indicating an upgradient source of contaminants.
- There was one open shaft, one open adit and at least five hazardous structures at the site.

**Block P. Mine PA# 23-001**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/07/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID     | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|--------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 07-090-SE-8  | 255        | 218        | 3 J        | 9 J        | 4.8        | 215 J      | 43700      | 0.161 J    | 2120 J     | 19 J       | 3390       | 5 U        | 749 J      | NR              |
| 07-090-SE-9  | 43         | 222        | 2.6 J      | 9.4 J      | 3.6        | 243 J      | 21400      | 0.057 J    | 2600 J     | 24 J       | 432        | 5 U        | 632 J      | NR              |
| 07-090-SE-10 | 28         | 88.8       | 0.6 U      | 4.4 J      | 1.8        | 140 J      | 13400      | 0.03 J     | 653 J      | 9 J        | 82         | 4 U        | 180 J      | NR              |
| 07-090-SE-11 | 101        | 608        | 33.3 J     | 13.8 J     | 8.5        | 1450 J     | 50200      | 0.178 J    | 10100 J    | 78 J       | 6800       | 15         | 7000 J     | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID     | As     | Ba   | Cd     | Co     | Cr   | Cu   | Fe    | Hg      | Mn   | Ni     | Pb   | Sb   | HARDNESS CALC. Zn (mg CaCO3/L) |
|--------------|--------|------|--------|--------|------|------|-------|---------|------|--------|------|------|--------------------------------|
| 07-090-SW-8  | 29     | 23.6 | 30.2   | 5.99 U | 5 U  | 239  | 11800 | 0.038 U | 7560 | 41.5   | 51.1 | 38.9 | 7090                           |
| 07-090-SW-9  | 0.98 U | 25.1 | 2.55 U | 5.99 U | 5.6  | 150  | 1370  | 0.038 U | 558  | 8.78 U | 37.6 | 32.1 | 585                            |
| 07-090-SW-10 | 2.09   | 20   | 2.55 U | 5.99 U | 5.13 | 6.77 | 403   | 0.038 U | 77.4 | 8.78 U | 2.52 | 33   | 54.3                           |
| 07-090-SW-11 | 0.98 U | 26.5 | 3.9    | 5.99 U | 5 U  | 234  | 1950  | 0.038 U | 840  | 8.78 U | 64   | 32.9 | 861                            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID     | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|--------------|------------------------|----------|---------|-----------|---------|
| 07-090-SW-8  | 274                    | < 5.0    | 178     | < 0.06    | NR      |
| 07-090-SW-9  | 182                    | < 5.0    | 86      | < 0.07    | NR      |
| 07-090-SW-10 | 130                    | < 5.0    | 35      | < 0.05    | NR      |
| 07-090-SW-11 | 218                    | < 5.0    | 113     | < 0.05    | NR      |

**LEGEND**

SE8 - Upstream of Belt Patent Mine, downstream of Block P. Mine.  
SE9 - Galena Creek above Block P. Mine, approx. 20' above old weir.  
SE10 - Green Creek before confluence with Galena Creek approx. 610'.  
SE11 - Daisy Creek before confluence with Green Creek.  
SW8 - Same as sample SE8.  
SW9 - same as sample SE9.  
SE10 - Same as sample SE10.  
SE11 - Same as sample SE11.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Marcelline</u>                     | County: <u>Judith Basin</u>                  |
| Legal Description: <u>T 15N R 9E</u>                  | Section(s): <u>SE 1/4, NW 1/4, Sec. 7</u>    |
| Mining District: <u>Hughesville</u>                   | Mine Type: <u>Hardrock/Ag, Pb, Zn</u>        |
| Latitude: <u>N 47° 04' 47"</u>                        | Primary Drainage: <u>Dry Fork Belt Creek</u> |
| Longitude: <u>W 110° 38' 04"</u>                      | USGS Code: <u>10030105</u>                   |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Galena Creek</u>      |
| Quad: <u>Barker</u>                                   | Date Investigated: <u>June 4, 1993</u>       |
| Inspectors: <u>Bullock, Flammang, Clark</u>           | P.A. # <u>23-022</u>                         |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no tailings on site.
- There were approximately 700 cubic yards of waste rock on site. The following elements were elevated at least three times background:  
Copper: 196 mg/kg  
Mercury: 0.464 to 0.87 mg/kg  
Lead: 12,000 mg/kg
- There were no discharging adits on site. There was one filled shaft on site was discharging approximately 4 gpm with a pH 3.08 and a specific conductance of 2190 umhos/cm. Cadmium, nickel, and antimony exceeded MCL/MCLGs. Acute aquatic life criteria were exceeded for cadmium, copper, and zinc. The chronic aquatic life criteria were exceeded for cadmium, copper, iron mercury, lead, nickel, and zinc.
- An adit discharge from the Danny T Mine, up-slope from this site, flowed through Waste Rock #4 prior to discharging into Galena Creek. This discharge exceeded the MCL/MCLGs for arsenic, cadmium, copper, nickel, and antimony. This discharge also exceeded the acute and chronic aquatic life criteria for arsenic, cadmium, copper, and zinc, as well as the chronic aquatic life criteria for iron, lead, and nickel.
- There were no observed releases documented on Galena Creek from the water samples (the creek has upgradient sources). Galena creek exceeded cadmium and antimony MCL/MCLGs both upstream and downstream from this site. The acute aquatic life criteria for cadmium, copper and zinc as well as the chronic aquatic life criteria for cadmium, copper, iron, lead, and zinc were exceeded in both the upstream and downstream Galena Creek samples. Therefore, these exceedances are not directly attributed to this site.
- There were two open adits and one partially open shaft (six feet) on site that were classified as hazardous mine openings.



**Marcelline PA# 23-022**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/04/93**

| SOLID MATRIX ANALYSES   |                |  |                                    |  |                  |                  |                  |  |  |            |            |            |            |                 |
|---|----------------|--|------------------------------------|--|------------------|------------------|------------------|--|--|------------|------------|------------|------------|-----------------|
| Metals in soils   |                | Results per dry weight basis             |                                    |  |                  |                  |                  |  |  |            |            |            |            |                 |
| FIELD ID  | As (mg/Kg)     | Ba (mg/Kg)                               | Cd (mg/Kg)                         | Co (mg/Kg)                                 | Cr (mg/Kg)       | Cu (mg/Kg)       | Fe (mg/Kg)       | Hg (mg/Kg)                                 | Mn (mg/Kg)                                 | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 23-022-WR-2   | 122            | 208 J                                    | 1.5 J                              | 2.07 J                                     | 1.41 J           | 31.1             | 23600            | 0.464                                      | 62.2                                       | 3.93       | 938        | 3.98 UJ    | 125        | NR              |
| 23-022-WR-4   | 334            | 245 J                                    | 14.4 J                             | 1.55 J                                     | 2.18 J           | 196              | 29700            | 0.87                                       | 145  | 2.76       | 12000      | 10 J       | 2170       | NR              |
| 07-090-SE-5   | 368            | 213                                      | 0.7 U                              | 6.7 J                                      | 4.7              | 146 J            | 56400            | 0.214 J                                    | 975 J                                      | 9 J        | 1410       | 5 U        | 566 J      | NR              |
| 23-046-SE-6   | 379            | 220                                      | 2.3 J                              | 11.9 J                                     | 7.3              | 139 J            | 66400            | 0.275 J                                    | 1800 J                                     | 11 J       | 4040       | 5 U        | 562 J      | NR              |
| 07-090-SE-7   | 154            | 59                                       | 0.8 J                              | 3.6 J                                      | 3.7              | 106 J            | 25200            | 0.177 J                                    | 438 J                                      | 3 J        | 584        | 4 U        | 152 J      | NR              |
| BACKGROUND  | 122 J          | 441 J                                    | 5.0                                | 9.66                                       | 26.5 J           | 22.7 J           | 33300            | 0.071                                      | 11900                                      | 75         | 375        | 4.24 J     | 1570       | NR              |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                |  |                                    |  |                  |                  |                  |  |  |            |            |            |            |                 |
| Acid/Base Accounting  |                |  |                                    |  |                  |                  |                  |  |  |            |            |            |            |                 |
| FIELD ID  | TOTAL SULFUR % | TOTAL SULFUR ACID BASE $\frac{1}{1000t}$ | NEUTRAL. POTENT. $\frac{1}{1000t}$ | SULFUR ACID BASE POTENT. $\frac{1}{1000t}$ | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE $\frac{1}{1000t}$ | SULFUR ACID BASE POTENT. $\frac{1}{1000t}$ |            |            |            |            |                 |
| 23-022-WR-2   | 1.75           | 54.7                                     | -0.8                               | -56  | 1.71             | < 0.01           | 0.04             | 0  | -0.83                                      |            |            |            |            |                 |
| 23-022-WR-4   | 1.09           | 34.1                                     | -4.4                               | -38  | 0.94             | 0.03             | 0.12             | 0.94                                       | -5.3                                       |            |            |            |            |                 |

| WATER MATRIX ANALYSES |                        |                 |         |           |         |      |        |         |        |      |      |        |                 |       |
|-----------------------|------------------------|-----------------|---------|-----------|---------|------|--------|---------|--------|------|------|--------|-----------------|-------|
| Metals in Water       |                        | Results in ug/L |         |           |         |      |        |         |        |      |      |        |                 |       |
| FIELD ID              | As                     | Ba              | Cd      | Co        | Cr      | Cu   | Fe     | Hg      | Mn     | Ni   | Pb   | Sb     | Zn (mg CaCO3/L) | CALC. |
| 23-022-GW-1           | 15.1                   | 2.24 U          | 365     | 106       | 5 U     | 277  | 51000  | 0.066 J | 183000 | 981  | 502  | 100    | 79500           | 781   |
| 23-022-GW-2           | 14.7                   | 2.24 U          | 369     | 111       | 5 U     | 264  | 52600  | 0.051 J | 186000 | 999  | 539  | 96     | 81000           | 791   |
| 23-022-SW-1           | 1600                   | 2.24 U          | 512     | 98.2      | 14.8    | 2730 | 248000 | 0.1 J   | 183000 | 969  | 137  | 126    | 108000          | 471   |
| 23-022-SW-2           | 1840                   | 5.43            | 513     | 86.7      | 13.3    | 2950 | 291000 | 0.079 J | 184000 | 965  | 216  | 125    | 108000          | 487   |
| 07-090-SW-5           | 38.7                   | 23              | 34.4    | 8.73      | 5 U     | 256  | 12600  | 0.038 U | 8940   | 45.9 | 59.6 | 50     | 7980            | 135   |
| 23-046-SW-6           | 13.9                   | 20.6            | 13.2    | 5.99 U    | 5 U     | 57.8 | 5150   | 0.087   | 869    | 10.9 | 14.5 | 18.3 U | 2130            | 76.9  |
| 07-090-SW-7           | 33                     | 23.7            | 34.7    | 6.77      | 5 U     | 265  | 12300  | 0.038 U | 8090   | 39.4 | 68.6 | 50.8   | 7790            | 142   |
| Wet Chemistry         |                        | Results in mg/l |         |           |         |      |        |         |        |      |      |        |                 |       |
| FIELD I.D.            | TOTAL DISSOLVED SOLIDS | CHLORIDE        | SULFATE | NO3/NO2-N | CYANIDE |      |        |         |        |      |      |        |                 |       |
| 23-022-GW-1           | 2220                   | < 5.0           | 1370    | 0.1       | NR      |      |        |         |        |      |      |        |                 |       |
| 23-022-GW-2           | 2190                   | < 5.0           | 1360    | < 0.05    | NR      |      |        |         |        |      |      |        |                 |       |
| 23-022-SW-1           | 2700                   | < 5.0           | 1610    | < 0.05    | NR      |      |        |         |        |      |      |        |                 |       |
| 23-022-SW-2           | 2800                   | < 5.0           | 1620    | < 0.05    | NR      |      |        |         |        |      |      |        |                 |       |
| 07-090-SW-5           | 308                    | < 5.0           | 182     | 0.06      | NR      |      |        |         |        |      |      |        |                 |       |
| 23-046-SW-6           | 141                    | < 5.0           | 60      | < 0.05    | NR      |      |        |         |        |      |      |        |                 |       |
| 07-090-SW-7           | 320                    | < 5.0           | 185     | 0.07      | NR      |      |        |         |        |      |      |        |                 |       |

WR2 - Composite of subsamples WR2A, 2B, 2C, 3A, 3B, and 3C.

WR4 - Composite of subsamples WR4A and 4B.

BACKGROUND - From the Bon Ton Mine (07-094-SS-1).

07-090-SE5 - Galena Creek downstream from the site

23-046-SE6 - Unnamed Trib. from Wright/Edwards at confluence with Galena Ck.

07-090-SE7 - Galena Creek upstream from the site.

GW1 - From the Marcelline Shaft.

GW2 - Duplicate of 23-022-GW-1.

SW1 - Eastern Tributary drainage @ confluence with Galena Creek.

SW2 - Eastern tributary drainage as it enters Marcelline property @ toe of the upgradient mine dump.

07-090-SW5 - Same as 07-090-SE5

23-046-SW5 - Same as 23-046-SE6

07-090-SW7 - Same as 07-090-SE7

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Belt Patent  
Legal Description: T 15N R 9E  
Mining District: Hughesville  
Latitude: N 47° 04' 47"  
Longitude: W 110° 38' 00"  
Land Status: Private/Public  
Quad: Barker  
Inspectors: Tuesday, Belanger, Lasher  
Organization: Pioneer Technical Services, Inc.

County: Judith Basin  
Section(s): NW 1/4, NE 1/4, Sec. 7  
Mine Type: Hardrock/Au, Pb, Zn  
Primary Drainage: Dry Fork Belt Creek  
USGS Code: 10030105  
Secondary Drainage: Galena Creek  
Date Investigated: June 4, 1993  
P.A. # 23-035

- The volume of tailings associated with this site was estimated to be 750 cubic yards. The tailings are actively eroding into Galena Creek. The following elements were elevated at least three times background in the samples collected:

|                            |                                |
|----------------------------|--------------------------------|
| Arsenic: 929 to 3520 mg/kg | Cadmium: 33.9J to 50.4J mg/kg  |
| Copper: 250 to 384 mg/kg   | Mercury: 1.4 to 2.1 mg/kg      |
| Lead: 9570 to 17,100 mg/kg | Antimony: 17.4J to 33.5J mg/kg |
| Zinc: 5440 to 7830 mg/kg   |                                |
- The volume of waste rock associated with this site was estimated to be approximately 65 cubic yards. No samples of the dump were collected for laboratory analysis; however, XRF measurements were taken.
- There were no adit discharges, seeps or springs observed at the site at the time of the investigation.
- Galena Creek flowed adjacent to the site on the west side. No observed release to surface water were attributed to the site. Contaminant concentrations measured in the upstream surface water sample were nearly identical to the concentrations measured in the downstream samples. MCLs were exceeded for cadmium and antimony both upstream and downstream of the site. Additionally, the chronic aquatic life criteria for iron, mercury, cadmium, copper, lead and zinc, and the acute aquatic life criteria for cadmium, copper, and zinc were exceeded both upstream and downstream from the site. The upgradient surface water sample indicated the presence of an upgradient contaminant source.

**Belt/Grace/Marcelline PA# 23-035**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 06/04/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID     | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|--------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 07-090-SE-7  | 154        | 59         | 0.8 J      | 3.6 J      | 3.7        | 106 J      | 25200      | 0.177 J    | 438 J      | 3 J        | 584        | 4 U        | 152 J      | NR              |
| 07-090-SE-8  | 255        | 218        | 3 J        | 9 J        | 4.8        | 215 J      | 43700      | 0.161 J    | 2120 J     | 19 J       | 3390       | 5 U        | 749 J      | NR              |
| 23-035-TP-1A | 929        | 1100 J     | 33.9 J     | 1.26 U     | 1.47 J     | 384        | 31200      | 2.1        | 77.6       | 1.85 U     | 17100      | 33.5 J     | 5440       | 1.128 U         |
| 23-035-TP-1B | 3520       | 884 J      | 50.4 J     | 1.39 J     | 0.98 U     | 250        | 76000      | 1.3        | 31         | 1.72 U     | 9570       | 17.4 J     | 7830       | 1.107 U         |
| BACKGROUND   | 122 J      | 441 J      | 5.0        | 9.66       | 26.5 J     | 22.7 J     | 33300      | 0.071      | 11900      | 75         | 375        | 4.24 J     | 1570       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 23-035-TP1A | 1.91           | 59.7                           | -4.3                     | -64                              | 1.01             | 0.22             | 0.68             | 6.87                             | -11.1                            |
| 23-035-TP1B | 2.84           | 88.7                           | -10                      | -99                              | 0.4              | 0.76             | 1.68             | 23.7                             | -34                              |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As | Ba   | Cd   | Co     | Cr  | Cu  | Fe    | Hg      | Mn   | Ni   | Pb   | Sb   | HARDNESS CALC. Zn(mg CaCO3/L) |
|-------------|----|------|------|--------|-----|-----|-------|---------|------|------|------|------|-------------------------------|
| 07-090-SW-7 | 33 | 23.7 | 34.7 | 6.77   | 5 U | 265 | 12300 | 0.038 U | 8090 | 39.4 | 68.6 | 50.8 | 7790                          |
| 07-090-SW-8 | 29 | 23.6 | 30.2 | 5.99 U | 5 U | 239 | 11800 | 0.038 U | 7560 | 41.5 | 51.1 | 38.9 | 7090                          |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID.   | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 07-090-SW-7 | 320                    | < 5.0    | 185     | 0.07      | NR      |
| 07-090-SW-8 | 274                    | < 5.0    | 178     | 0.06      | NR      |

**LEGEND**

SE7 - Downstream in Galena Creek.  
SE8 - Upstream in Galena Creek.  
TP1A - Composite of subsamples TP1A and 2A.  
TP1B - Sample of the TP1B subsample.  
BACKGROUND - From the Bon Ton Mine (07-094-SS-1).

SW7 - Same as sample SE7.  
SW8 - Same as sample SE8.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: NE SE S7 (Lucky Strike)  
Legal Description: T 15N R 9E  
Mining District: Hughesville  
Latitude: N 47° 04' 28"  
Longitude: W 110° 38' 00"  
Land Status: Private/Public  
Quad: Barker  
Inspectors: Tuesday, Belanger, Lasher  
Organization: Pioneer Technical Services, Inc.

County: Judith Basin  
Section(s): NE 1/4, NE 1/4, Sec. 7  
Mine Type: Hardrock/Ag. Pb, Zn  
Primary Drainage: Dry Fork Belt Creek  
USGS Code: 10030105  
Secondary Drainage: Galena Creek  
Date Investigated: June 4, 1993  
P.A. # 23-042

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be approximately 5,000 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 272 to 368 mg/kg  
Copper: 85.6 to 146J mg/kg  
Mercury: 0.214 to 0.458 mg/kg
- A minor discharge from the on site adit was observed at the time of the investigation. No MCLs/MCLGs or Montana Numeric Water Quality Standards were exceeded in the adit discharge. The discharge combined with an unnamed tributary which flowed over and through WR-1 and then discharged to Galena Creek. A second surface water sample was collected from the discharge after flowing through the waste rock dump. There were no MCL exceedances; however, acute aquatic life criteria were exceeded for cadmium, copper, and zinc, and chronic aquatic life criteria were exceeded for copper, lead, and zinc.
- Surface water samples were collected upstream and downstream from the site in Galena Creek. MCLs were exceeded for cadmium and antimony in both the upstream and downstream samples. Chronic aquatic life criteria for iron, cadmium, copper, lead, and zinc were exceeded in the both the upstream and downstream samples. Acute aquatic life criteria were exceeded for cadmium, copper, lead and zinc in both the upstream and downstream samples; additionally, acute aquatic life criteria for cadmium was exceeded in the upstream sample.
- There was little stream bank vegetation observed, and predominant iron oxide staining was evident during the investigation.
- There was a shaft observed above the adit which had caved and poses a safety hazard.



NE SE Sec. 7 (Lucky Strike) PA# 23-042  
AMRB HAZARDOUS MATERIALS INVENTORY  
INVESTIGATOR: PIONEER - TUESDAY  
INVESTIGATION DATE: 06/04/93

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 07-090-SE-4 | 272        | 147        | 3.6 J      | 3.2 J      | 5.1        | 107 J      | 45900      | 0.097 J    | 651 J      | 6 J        | 1590       | 4 U        | 811 J      | NR              |
| 07-090-SE-5 | 368        | 213        | 0.7 U      | 6.7 J      | 4.7        | 146 J      | 56400      | 0.214 J    | 975 J      | 9 J        | 1410       | 5 U        | 566 J      | NR              |
| 23-042-WR-1 | 283        | 195 J      | 1.1 J      | 1.15 U     | 0.96 U     | 85.6       | 32400      | 0.458      | 180        | 2.75       | 971        | 3.5 UJ     | 135        | NR              |
| BACKGROUND  | 122 J      | 441 J      | 5          | 9.66       | 26.5 J     | 22.7 J     | 33300      | 0.071      | 11900      | 75         | 375        | 4.24 J     | 1570       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID   | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 23-042-WR1 | 0.63           | 19.7                           | -3.5                    | -23                              | 0.57             | < 0.01           | 0.06             | 0                                | -3.53                            |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co     | Cr  | Cu   | Fe    | Hg      | Mn   | Ni   | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|------|--------|--------|-----|------|-------|---------|------|------|------|--------|-----------------|----------------|
| 23-042-SW-1 | 3.24 | 18   | 2.55 U | 5.99 U | 5 U | 5.2  | 512   | 0.086 J | 5220 | 37.8 | 2.53 | 18.3 U | 403             | 164            |
| 23-042-SW-2 | 2.95 | 46.8 | 2.55 U | 6.4    | 5 U | 19.2 | 635   | 0.054 J | 2730 | 23.6 | 2.91 | 18.3 U | 208             | 59.3           |
| 07-090-SW-4 | 38.8 | 22.7 | 36.5   | 9.03   | 5 U | 246  | 11600 | 0.038 U | 8670 | 43.4 | 121  | 53.8   | 7750            | 131            |
| 07-090-SW-5 | 38.7 | 23   | 34.4   | 8.73   | 5 U | 256  | 12600 | 0.038 U | 8940 | 45.9 | 59.6 | 50     | 7980            | 135            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 23-042-SW-1 | 279                    | < 5.0    | 177     | < 0.05    | NR      |
| 23-042-SW-2 | 115                    | < 5.0    | 70      | 0.05      | NR      |
| 07-090-SW-4 | 318                    | < 5.0    | 181     | 0.05      | NR      |
| 07-090-SW-5 | 308                    | < 5.0    | 182     | 0.06      | NR      |

**LEGEND**

SE4 - Downgradient Galena Creek.  
SE5 - Upgradient Galena Creek.  
WR1 - Composite of subsamples WR1 and 2A through 2C.  
BACKGROUND - From Silver Dyke Adit (07-135-S8-1).

SW1 - Adit discharge.  
SW2 - Discharge from bottom of dump.  
SW4 - Same as sample SE4.  
SW5 - Same as sample SE5.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Wright Lode  
Legal Description: T 15N R 9E  
Mining District: Hughesville  
Latitude: N 47° 05' 03"  
Longitude: W 110° 38' 23"  
Land Status: Private/Public  
Quad: Barker  
Inspectors: Bullock, Flammang, Clark  
Organization: Pioneer Technical Services, Inc.

County: Judith Basin  
Section(s): NW 1/4, NW 1/4, Sec. 7  
Mine Type: Hardrock/Pb, Ag, Zn  
Primary Drainage: Dry Fork Belt Creek  
USGS Code: 10030105  
Secondary Drainage: Galena Creek  
Date Investigated: June 7, 1993  
P.A. # 23-045

- There were no mill tailings observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 19,900 cubic yards. The following elements were elevated at least three times background:

|                             |                                 |
|-----------------------------|---------------------------------|
| Arsenic: 280 to 316 mg/kg   | Mercury: 0.427J to 0.649J mg/kg |
| Cadmium: 3.4J mg/kg         | Lead: 8,430 to 14,200 mg/kg     |
| Copper: 83.6J to 246J mg/kg | Zinc: 393J to 640J mg/kg        |
- There were no mine opening discharges, seeps or springs identified at this site.
- A storm runoff event was occurring during the investigation. An unnamed tributary to Galena Creek flowed directly through the site (over and through WR-3 and WR-4). The MCL/MCLG for antimony was exceeded in both upstream and downstream surface water samples collected from the tributary. Observed releases to surface water were documented for arsenic, cadmium, copper, mercury, lead, and zinc. MCL/MCLGs for arsenic and cadmium were exceeded in the downstream sample and were directly attributable to the site. Acute and chronic aquatic life criteria were exceeded for arsenic, cadmium, and lead in the downstream sample, and chronic aquatic life criteria were exceeded for iron, mercury, and copper in the downstream sample. The acute and chronic aquatic life criteria exceedances for arsenic, cadmium, and lead and the chronic aquatic life criteria exceedances for mercury and copper were directly attributable to the site.
- Several potentially hazardous pits and trenches were scattered throughout the area, ranging to 10 feet deep. Several of the waste rock dumps had very steep and unstable banks.

**Wright Lode PA# 23-045**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/07/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 23-045-WR-2 | 280        | 183        | 3.4 J      | 1.2 U      | 2.1        | 246 J      | 21400      | 0.427 J    | 16.7 J     | 2 U        | 8430       | 4 U        | 640 J      | NR              |
| 23-045-WR-4 | 316        | 170        | 1.7 J      | 1.2 U      | 1.2        | 83.6 J     | 17900      | 0.649 J    | 22.6 J     | 3 J        | 14200      | 11         | 393 J      | NR              |
| BACKGROUND  | 29         | 270        | 0.6 U      | 3.1 J      | 7          | 11.6 J     | 11100      | 0.053 J    | 359 J      | 5 J        | 241        | 5 U        | 28 J       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 23-045-WR-2 | 1.42           | 44.4                           | -4.8                    | -49                              | 1.24             | 0.02             | 0.16             | 0.62                             | -5.44                            |
| 23-045-WR-4 | 1.6            | 50                             | -3.3                    | -53                              | 1.55             | <0.01            | 0.05             | 0                                | -3.33                            |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co     | Cr  | Cu     | Fe    | Hg      | Mn    | Ni     | Pb    | Sb   | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|--------|--------|-----|--------|-------|---------|-------|--------|-------|------|-----------------|----------------|
| 23-045-SW-1 | 888    | 182  | 79     | 14.4   | 5.2 | 624    | 79300 | 1.02    | 4560  | 29.8   | 12700 | 64.7 | 14500           | 47.9           |
| 23-045-SW-2 | 0.98 U | 44.1 | 2.55 U | 5.99 U | 5 U | 1.35 U | 26.7  | 0.038 U | 2.6 U | 8.78 U | 0.48  | 27.9 | 75.2            | 8.6            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 23-045-SW-1 | 486                    | < 5.0    | 229     | < 0.05    | NR      |
| 23-045-SW-2 | 106                    | < 5.0    | 11      | < 0.05    | NR      |

**LEGEND**

WR2 - Composite of subsamples WR2A, 2B, and 3.  
 WR4 - Composite of subsamples WR4A, 4B, 4D, and 4E.  
 BACKGROUND - From the Wright Lode (23-045-SS-1).

SW1 - At base of waste rock dump 4.  
 SW2 - Above waste rock dump 3.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Edwards</u>                        | County: <u>Judith Basin</u>                     |
| Legal Description: <u>T 15N R 9E</u>                  | Section(s): <u>NW 1/4, NW 1/4, Sec. 7</u>       |
| Mining District: <u>Hughesville</u>                   | Mine Type: <u>Hardrock/Ag, Pb, Zn</u>           |
| Latitude: <u>N 47° 04' 55"</u>                        | Primary Drainage: <u>Galena Creek</u>           |
| Longitude: <u>W 110° 38' 16"</u>                      | USGS Code: <u>10030105</u>                      |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Unnamed tributary to</u> |
| Quad: <u>Barker</u>                                   | <u>Galena Creek</u>                             |
| Inspectors: <u>Babits, Lasher/Pierson</u>             | Date Investigated: <u>June 7, 1993</u>          |
| Organization: <u>Pioneer Technical Services, Inc/</u> | P.A. # <u>23-046</u>                            |
| <u>Thomas, Dean &amp; Hoskins, Inc.</u>               |   |

- There are no tailings on site.
- There are approximately 50,750 cubic yards of uncovered waste rock on site. The following were elevated at least three times background:

|                    |                      |
|--------------------|----------------------|
| Arsenic: 649 mg/kg | Cadmium: 3.3J mg/kg  |
| Copper: 499J mg/kg | Mercury: 1.87J mg/kg |
| Lead: 24,900 mg/kg | Antimony: 19 mg/kg   |
| Zinc: 827J mg/kg   |                      |
- There were no discharging adits on site.
- The creek ran through waste rock. There were no observed releases to downstream surface water (there was an upgradient contaminant source). Arsenic and antimony exceeded MCLs in downstream surface water which were directly attributable to the site. The acute and chronic aquatic life criteria was exceeded for arsenic, copper, lead, and zinc in downstream surface water. The chronic aquatic life criteria was exceeded for iron in downstream surface water.
- There was one open adit on site.



**Edwards PA# 23-046**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 06/07/93**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | Cyanide (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 23-046-SE-2 | 526        | 182        | 3.5 J      | 1.4 U      | 1.4        | 68.4 J     | 19700      | 0.187 J    | 131 J      | 2 U        | 4740       | 4          | 645 J      | NR              |
| 23-046-SE-6 | 379        | 220        | 2.3 J      | 11.9 J     | 7.3        | 139 J      | 66400      | 0.275 J    | 1800 J     | 11 J       | 4040       | 5 U        | 562 J      | NR              |
| 23-046-WR-2 | 649        | 170        | 3.3 J      | 1.6 U      | 2.2        | 499 J      | 28400      | 1.87 J     | 10.9 J     | 4 J        | 24900      | 19         | 827 J      | NR              |
| BACKGROUND  | 29         | 270 J      | 0.6 U      | 3.1 J      | 7          | 11.6 J     | 11100      | 0.053 J    | 359 J      | 5 J        | 241        | 5 U        | 28 J       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**WATER MATRIX ANALYSES**

**Metals in Water**  
**Results in ug/L**

| FIELD ID    | As   | Ba   | Cd   | Co     | Cr   | Cu   | Fe     | Hg    | Mn   | Ni   | Pb    | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|------|------|--------|------|------|--------|-------|------|------|-------|--------|-----------------|----------------|
| 23-045-SW-1 | 888  | 182  | 79   | 14.4   | 5.2  | 624  | 79300  | 1.02  | 4560 | 29.8 | 12700 | 64.7   | 14500           | 47.9           |
| 23-046-SW-2 | 1020 | 164  | 106  | 15.5   | 8.13 | 812  | 105000 | 1.05  | 6640 | 49.1 | 12800 | 48     | 19400           | 73.3           |
| 23-046-SW-6 | 13.9 | 20.6 | 13.2 | 5.99 U | 5 U  | 57.8 | 5150   | 0.087 | 869  | 10.9 | 14.5  | 18.3 U | 2130            | 76.9           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision

**Wet Chemistry**

**Results in mg/l**

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 23-045-SW-1 | 486                    | < 5.0    | 229     | < 0.05    | NR      |
| 23-046-SW-2 | 730                    | < 5.0    | 381     | < 0.05    | NR      |
| 23-046-SW-6 | 141                    | < 5.0    | 60      | < 0.05    | NR      |

**LEGEND**

SE2 - Below waste rock dump 1 in tributary.  
 SE6 - Unnamed tributary just prior to confluence with Galena Creek.  
 WR2 - Composite of subsamples WR2A, 2B, 2C, 2D, and 2E.  
 BACKGROUND - From the Wright Lode Mine (23-045-SS-1).

SW1 - At base of waste rock dump 4 from 23-045 site.  
 Upgradient sample of the Edwards Mine.  
 SW2 - Same as sample SE2.  
 SW6 - Same as sample SE6.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Harrison</u>                       | County: <u>Judith Basin</u>                   |
| Legal Description: T <u>15N</u> R <u>9E</u>           | Section(s): <u>SE 1/4, NE 1/4, Sec. 6</u>     |
| Mining District: <u>Hughesville</u>                   | Mine Type: <u>Hardrock/Ag, Pb, Zn</u>         |
| Latitude: <u>N 47° 05' 24"</u>                        | Primary Drainage: <u>Galena Creek and Dry</u> |
| Longitude: <u>W 110° 37' 22"</u>                      | <u>Fork Belt Creek</u>                        |
| Land Status: <u>Private/Public</u>                    | USGS Code: <u>10030105</u>                    |
| Quad: <u>Mixes Baldy</u>                              | Secondary Drainage: <u>Daisy Creek</u>        |
| Inspectors: <u>Bullock, Flammang, Clark</u>           | Date Investigated: <u>June 3, 1993</u>        |
| Organization: <u>Pioneer Technical Services, Inc.</u> | P.A. # <u>23-056</u>                          |

- There were no mill tailings observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 10,500 cubic yards. The following elements were elevated at least three times background:

|                      |                         |
|----------------------|-------------------------|
| Arsenic: 182J mg/kg  | Iron: 90,300 mg/kg      |
| Barium: 670J mg/kg   | Mercury: 0.75 mg/kg     |
| Cadmium: 9 mg/kg     | Manganese: 12,800 mg/kg |
| Copper: 1,270J mg/kg | Nickel: 68.5 mg/kg      |
| Lead: 10,600 mg/kg   | Zinc: 390 mg/kg         |
- One discharging adit was observed at the site during the investigation. The adit was discharging at 0.25 cfs, with a pH of 6.10 and a specific conductance of 680 umhos/cm. The MCL for cadmium was exceeded in the adit discharge. Acute and chronic aquatic life criteria were exceeded for copper and zinc in the adit discharge, and chronic aquatic life criteria were exceeded for cadmium and lead.
- The surface water samples collected on Daisy Creek did not document an observed release to surface water attributable to this site. The MCL/MCLG for cadmium was exceeded in surface water samples collected both upstream and downstream of the site in Daisy Creek. Acute and chronic aquatic life criteria were exceeded for copper, lead, and zinc, and chronic aquatic life criteria were exceeded for iron and cadmium, in both upstream and downstream samples. The acute and chronic aquatic life criteria for cadmium, and the chronic aquatic life criteria for mercury were exceeded in the upstream sample on Daisy Creek. Observed releases to Daisy Creek were documented in the stream sediment samples collected for arsenic, copper, iron, mercury, and lead; although, the data indicated likely additional upstream contaminant sources.
- One potentially hazardous collapsing cabin was observed at the site, and several of the waste rock dumps were very steep and unstable.

**Harrison/Moulton PA# 23-056**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/03/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 23-056-SE-1 | 306 J      | 1720 J     | 12.2       | 4.03       | 5.2 J      | 2590 J     | 151000     | 1.1        | 8610       | 47.2       | 13400      | 14 J       | 3590       | NR              |
| 23-056-SE-2 | 58.6 J     | 825 J      | 4.3        | 5.91       | 7.46 J     | 374 J      | 44000      | 0.106      | 4820       | 35.1       | 4360       | 4.24 UJ    | 2120       | NR              |
| 23-056-WR-1 | 182 J      | 670 J      | 9.0        | 3.2        | 6.24 J     | 1270 J     | 90300      | 0.75       | 12800      | 68.5       | 10600      | 6.43 J     | 2330       | NR              |
| BACKGROUND  | 5.1 J      | 159 J      | 0.6 U      | 3.83       | 8.09 J     | 9.81 J     | 13300      | 0.028      | 548        | 7.93       | 61.4       | 3.98 UJ    | 130        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 23-056-WR-1 | 4.26           | 133                            | 66.4                    | -67                              | 1.53             | 1.08             | 1.65             | 33.7                             | 32.6                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd   | Co     | Cr  | Cu    | Fe   | Hg      | Mn   | Ni   | Pb   | Sb     | HARDNESS CALC. Zn (mg CaCO3/L) |
|-------------|--------|------|------|--------|-----|-------|------|---------|------|------|------|--------|--------------------------------|
| 23-056-GW-1 | 0.98 U | 19.8 | 11.4 | 5.99 U | 5 U | 516 J | 704  | 0.038 U | 2970 | 23.9 | 26.8 | 18.3 U | 2470 JX 355                    |
| 23-056-SW-1 | 1.37   | 32.5 | 6.37 | 5.99 U | 5 U | 325 J | 4760 | 0.038 U | 1990 | 21.9 | 312  | 18.3 U | 2060 JX 214                    |
| 23-056-SW-2 | 0.98 U | 19.9 | 8.3  | 5.99 U | 5 U | 133 J | 4530 | 0.043   | 1600 | 19.9 | 369  | 18.3 U | 2340 JX 127                    |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 23-056-GW-1 | 495                    | < 5.0    | 217     | 0.11      | NR      |
| 23-056-SW-1 | 307                    | < 5.0    | 178     | 0.11      | NR      |
| 23-056-SW-2 | 200                    | < 5.0    | 129     | 0.16      | NR      |

**LEGEND**

SE1 - Downstream of dumps and confluence of adit discharge.  
SE2 - Upstream of possible influence from dumps.  
WR1 - Composite of subsamples WR1A, 1B, 1C, 2A, 2B, and 2C.  
BACKGROUND - From the Tiger Mine (23-059-SS-1).

GW1 - Adit discharge.  
SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Moulton  
Legal Description: T 15N R 9E  
Mining District: Hughesville  
Latitude: N 47° 05' 27"  
Longitude: W 110° 36' 58"  
Land Status: Private/Public  
Quad: Mixes Baldy  
Inspectors: Tuesday, Belanger, Lasher  
Organization: Pioneer Technical Services, Inc.

County: Judith Basin  
Section(s): SW 1/4, NW 1/4, Sec. 5  
Mine Type: Hardrock/Ag, Pb, Zn, Au  
Primary Drainage: Dry Fork Belt Creek  
USGS Code: 10030105  
Secondary Drainage: Daisy Creek  
Date Investigated: June 3, 1993  
P.A. # 23-058

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be approximately 975 cubic yards. The following elements were elevated at least three times background:

|                      |                        |
|----------------------|------------------------|
| Arsenic: 57.2J mg/kg | Mercury: 0.261 mgj/kg  |
| Barium: 794J mg/kg   | Manganese: 8,360 mg/kg |
| Cadmium: 5 mg/kg     | Nickel: 52.7 mg/kg     |
| Copper: 618J mg/kg   | Lead: 22,400 mg/kg     |
| Iron: 65,300 mg/kg   | Zinc: 1,540 mg/kg      |
- One adit discharge was associated with this site, which flowed across the dump into intermittent Daisy Creek. The adit discharge exceeded the MCL for cadmium. Acute aquatic life criteria were exceeded for cadmium, copper, lead, and zinc. Chronic aquatic life criteria were exceeded for arsenic, cadmium, copper, iron, mercury, copper, lead, and zinc. The adit discharge pH measurement was 4.11 and specific conductance was 1,220 umhos/cm.
- No observed releases to surface water were documented for this site; although, waste rock was observed in the stream channel and vegetation was lacking along the stream bank for more than 50 feet downstream from the adit confluence. The downstream sample in Daisy Creek exceeded the MCL for cadmium; however, the upstream sample in Daisy Creek also exceeded the MCL for cadmium, indicating the presence of an upgradient contaminant source (Tiger Mine). Several acute and chronic aquatic life criteria were exceeded in both the upstream and downstream samples in Daisy Creek.



**Moulton PA# 23-058**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 06/03/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 23-058-SE-1 | 89 J       | 617 J      | 5.8        | 5.29       | 18 J       | 299 J      | 108000     | 0.146      | 2370       | 21.5       | 8670       | 8.19 J     | 2440       | NR              |
| 23-058-SE-2 | 47.1 J     | 871 J      | 2.6        | 1.45 U     | 4.69 J     | 241 J      | 52300      | 0.302      | 674        | 8.7        | 6620       | 4.68 J     | 1200       | NR              |
| 23-058-WR-1 | 57.2 J     | 794 J      | 4.7        | 5.63       | 8.79 J     | 618 J      | 65300      | 0.261      | 8360       | 52.7       | 22400      | 8.85 J     | 1540       | NR              |
| BACKGROUND  | 5.1 J      | 159 J      | 0.6 U      | 3.83       | 8.09 J     | 9.81 J     | 13300      | 0.028      | 548        | 7.93       | 61.4       | 3.98 UJ    | 130        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID   | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 23-058-WR1 | 2.89           | 90.3                           | 117                      | 26.8                             | 0.37             | 1.48             | 1.04             | 46.2                             | 70.8                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd   | Co     | Cr  | Cu    | Fe    | Hg      | Mn    | Ni   | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|------|--------|-----|-------|-------|---------|-------|------|------|--------|-----------------|----------------|
| 23-058-SW-1 | 0.98 U | 33.8 | 20   | 5.99 U | 5 U | 186 J | 9450  | 0.038 U | 2530  | 36.3 | 667  | 21.9   | 4950 JX         | 160            |
| 23-058-SW-2 | 2.42   | 30.3 | 22.3 | 5.99 U | 5 U | 377   | 15100 | 0.079 J | 5360  | 48.1 | 958  | 18.3 U | 5990            | 218            |
| 23-058-SW-3 | 3.56   | 10.8 | 34.7 | 11.5   | 5 U | 917   | 41900 | 0.068 J | 12400 | 92.8 | 1660 | 18.3 U | 7980            | 327            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 23-058-SW-1 | 265                    | < 5.0    | 173     | 0.28      | NR      |
| 23-058-SW-2 | 365                    | < 5.0    | 244     | 0.27      | NR      |
| 23-058-SW-3 | 714                    | < 5.0    | 470     | 0.3       | NR      |

**LEGEND**

SE1 - Upgradient Daisy Creek.  
SE2 - Downgradient Daisy Creek.  
WR1 - Composite of subsamples WR1A and 1B.  
BACKGROUND - From the Tiger Mine (23-059-SS-1).

SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.  
SW3 - Adit discharge.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Tiger  
Legal Description: T 15N R 9E  
Mining District: Hughesville  
Latitude: N 47° 05' 29"  
Longitude: W 110° 36' 50"  
Land Status: Private/Public  
Quad: Mixes Baldy  
Inspectors: Tuesday, Belanger, Lasher  
Organization: Pioneer Technical Services, Inc.

County: Judith Basin  
Section(s): SW 1/4, NW 1/4, Sec. 5  
Mine Type: Hardrock/Pb, Ag, Zn  
Primary Drainage: Dry Fork Belt Creek  
USGS Code: 10030105  
Secondary Drainage: Daisy Creek  
Date Investigated: June 3, 1993  
P.A. # 23-059

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be approximately 8,200 cubic yards. The following elements were elevated at least three times background:

|                               |                              |
|-------------------------------|------------------------------|
| Arsenic: 41.6J to 61.7J mg/kg | Mercury: 0.177 mg/kg         |
| Cadmium: 5 to 13 mg/kg        | Manganese: 5,060 mg/kg       |
| Copper: 221J to 347J mg/kg    | Nickel: 32.7 mg/kg           |
| Iron: 183,000 mg/kg           | Lead: 15,900 to 16,600 mg/kg |
| Antimony: 15.3J mg/kg         | Zinc: 1,770 to 5,460 mg/kg   |
- Two adit discharges were associated with this site. Adit #1 had major flow (0.025 cfs); adit #4 had a slight discharge (not sampled) which seeped into the waste rock dump. The discharge from adit #1 exceeded the MCL for cadmium, as well as acute aquatic life criteria for cadmium, copper, lead, and zinc. The discharge from adit #1 also exceeded chronic aquatic life criteria for iron, cadmium, copper, lead, and zinc. The adit #1 discharge pH measurement was 5.9.
- The adit #1 discharge makes up the majority of the flow in intermittent Daisy Creek. Observed releases were documented for arsenic, cadmium, copper, iron, manganese, nickel, lead, and zinc in sediments and water. The MCL for cadmium was exceeded in the downstream Daisy Creek sample, which was directly attributed to the site. Additionally, acute aquatic life criteria were exceeded for copper, lead, and zinc, and chronic aquatic life criteria were exceeded for iron, copper, and zinc, which can all be directly attributed to the site.
- The on-site shaft was open and was potentially hazardous.

**Tiger PA# 23-059**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 06/03/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 23-059-SE-1 | 7.17 J     | 142 J      | 0.6 U      | 2.75       | 4.63 J     | 21.9 J     | 11500      | 0.09       | 542        | 7.09       | 165        | 4.48 UJ    | 179        | NR              |
| 23-059-SE-3 | 58.3 J     | 381 J      | 14.5       | 4.57       | 10.8 J     | 325 J      | 71200      | 0.09       | 3850       | 29.8       | 8590       | 8.52 J     | 5140       | NR              |
| 23-059-WR-1 | 61.7 J     | 86.5 J     | 4.6        | 2.23       | 5.36 J     | 347 J      | 183000     | 0.051      | 556        | 6.46       | 16600      | 4.5 J      | 1770       | NR              |
| 23-059-WR-2 | 41.6 J     | 403 J      | 12.5       | 3.84       | 5.57 J     | 221 J      | 32000      | 0.177      | 5060       | 32.7       | 15900      | 15.3 J     | 5460       | NR              |
| BACKGROUND  | 5.1 J      | 159 J      | 0.6 U      | 3.83       | 8.09 J     | 9.81 J     | 13300      | 0.028      | 548        | 7.93       | 61.4       | 3.98 UJ    | 130        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID   | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 23-059-WR1 | 27.6           | 862                            | -0.1                     | -862                             | 4.32             | 2.87             | 20.4             | 89.7                             | -89.7                            |
| 23-059-WR2 | 2.01           | 62.8                           | 20.5                     | -42                              | 1.28             | 0.16             | 0.57             | 5                                | 15.5                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co     | Cr     | Cu    | Fe    | Hg      | Mn   | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|--------|--------|--------|-------|-------|---------|------|--------|------|--------|-----------------|----------------|
| 23-059-SW-1 | 0.98 U | 47.7 | 2.55 U | 5.99 U | 5 U    | 2.7 J | 33.3  | 0.038 U | 4.4  | 8.78 U | 4.33 | 21.8   | 7.8 JX          | 57.3           |
| 23-059-SW-2 | 2.33   | 31.4 | 14.1   | 5.99 U | 7.53 J | 353 J | 14300 | 0.038 U | 2160 | 25.6   | 657  | 18.3 U | 3610 JX         | 144            |
| 23-059-SW-3 | 1.64   | 38   | 14     | 5.99 U | 5 U    | 137 J | 5630  | 0.038 U | 1320 | 23.6   | 343  | 18.3 U | 3460 JX         | 136            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID.   | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 23-059-SW-1 | 80                     | < 5.0    | 11      | 0.09      | NR      |
| 23-059-SW-2 | 245                    | < 5.0    | 155     | 0.66      | NR      |
| 23-059-SW-3 | 232                    | < 5.0    | 126     | 0.27      | NR      |

**LEGEND**

SE1 - Upstream.

SE3 - Downstream.

WR1 - Composite of subsamples WR1A, 1B, and 1C.

WR2 - Composite of subsamples WR2A, 2B, and 2C.

BACKGROUND - South of site across Daisy Creek near clear cut  
From Tiger Mine (23-059-SS-1).

SW1 - Same as sample SE1.

SW2 - Adit discharge.

SW3 - Same as sample SE3.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Vortex</u>                         | County: <u>Judith Basin</u>                  |
| Legal Description: T <u>13N</u> R <u>11E</u>          | Section(s): <u>SW 1/4, SW 1/4, Sec. 21</u>   |
| Mining District: <u>Yogo</u>                          | Mine Type: <u>Hardrock/Yogo sapphires</u>    |
| Latitude: <u>N 46° 52' 15"</u>                        | Primary Drainage: <u>Judith River</u>        |
| Longitude: <u>W 110° 20' 42"</u>                      | USGS Code: <u>10040103</u>                   |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Yogo Creek</u>        |
| Quad: <u>Indian Hill</u>                              | Date Investigated: <u>September 10, 1993</u> |
| Inspectors: <u>Bullock, S. Babits</u>                 | P.A. # <u>23-027</u>                         |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- The volume of tailings currently associated with this site were estimated to be approximately 450 cubic yards. The volume may increase due to active mining and milling at this site. The tailings impoundment was in very good condition. Arsenic (44.5 mg/kg) was the only element that exceeded three times the background sample concentration.
- There was currently no waste rock associated with this site. All of the material removed from the shaft was processed through the mill.
- There were no adit/shaft discharges, springs or seeps associated with this site.
- Yogo Creek flowed through this site. The active shaft was on the north side of the creek and the mill and tailings impoundment were on the south side of the creek. The tailings impoundment was constructed within the floodplain of the creek. No observed releases attributable to this site were documented from this investigation. No MCLs or MCLGs were exceeded. In addition, no aquatic life criteria were exceeded that could be attributed to this site.
- Surface water and sediment sample data collected indicated minor impacts to Yogo Creek attributable to the Ronco Mine located directly upstream from this site.



**Vortex PA# 23-027**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER-BULLOCK**  
**INVESTIGATION DATE: 9/10/93**

| SOLID MATRIX ANALYSES                           |                |                                |                         |                                  |                  |                  |                  |                                  |                                  |   |            |            |            |                 |
|---|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|---|------------|------------|------------|-----------------|
| Metals in soils<br>Results per dry weight basis |                |                                |                         |                                  |                  |                  |                  |                                  |                                  |   |            |            |            |                 |
| FIELD ID  | As (mg/Kg)     | Ba (mg/Kg)                     | Cd (mg/Kg)              | Co (mg/Kg)                       | Cr (mg/Kg)       | Cu (mg/Kg)       | Fe (mg/Kg)       | Hg (mg/Kg)                       | Mn (mg/Kg)                       | Ni (mg/Kg)  | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 23-027-SE-1                                     | 22.2           | 335                            | 1.0 U                   | 3.38                             | 19.1             | 4.82             | 8770             | 0.037 U                          | 332                              | 24  | 7.3 U      | 7.05 UJ    | 41.1       | NR              |
| 23-027-SE-2                                     | 15.2           | 468                            | 1.3 U                   | 9.86                             | 45.2             | 23.9             | 17000            | 0.045 U                          | 392                              | 44.4  | 21.9       | 9.17 UJ    | 90.9       | NR              |
| 23-027-SE-3                                     | 14             | 385                            | 1.0 U                   | 8.21                             | 37               | 19.5             | 15000            | 0.052 J                          | 322                              | 36.9  | 14.7       | 7.2 UJ     | 61.9       | NR              |
| 23-027-TP-1                                     | 44.5           | 0.166 U                        | 0.7 U                   | 4.11                             | 13.2             | 0.351 U          | 5540             | 0.039 J                          | 137                              | 18.9  | 4.94 U     | 4.76 UJ    | 1.31 U     | NR              |
| BACKGROUND                                      | 14.1           | 155                            | 1.1 U                   | 3.29                             | 14.5             | 6.4              | 12200            | 0.037 J                          | 330                              | 11.6  | 9.65       | 7.34 UJ    | 44.6       | NR              |
|   |                |                                |                         |                                  |                  |                  |                  |                                  |                                  | U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |            |            |            |                 |
| Acid/Base Accounting                            |                |                                |                         |                                  |                  |                  |                  |                                  |                                  |   |            |            |            |                 |
| FIELD ID  | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |   |            |            |            |                 |
| 23-027-TP-1                                     | <0.01          | 0                              | 905                     | 905                              | <0.01            | <0.01            | 0.12             | 0                                | 905                              |   |            |            |            |                 |
| MECHANICAL ANALYSIS                             |                |                                |                         |                                  |                  |                  |                  |                                  |                                  |   |            |            |            |                 |
| FIELD ID  | % CLAY         | % SAND                         | % SILT                  | % COARSE MATERIAL (>2mm)         |                  |                  |                  |                                  |                                  |   |            |            |            |                 |
| 23-027-SE-1                                     | 2              | 95                             | 4                       | 55                               |                  |                  |                  |                                  |                                  |   |            |            |            |                 |
| 23-027-SE-2                                     | 10             | 63                             | 27                      | 0                                |                  |                  |                  |                                  |                                  |   |            |            |            |                 |
| 23-027-SE-3                                     | 4              | 63                             | 33                      | 0                                |                  |                  |                  |                                  |                                  |   |            |            |            |                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

| WATER MATRIX ANALYSES              |                        |                        |          |         |           |         |     |        |         |        |      |          |        |                    |  |
|------------------------------------|------------------------|------------------------|----------|---------|-----------|---------|-----|--------|---------|--------|------|----------|--------|--------------------|--|
| Metals in Water<br>Results in ug/L |                        |                        |          |         |           |         |     |        |         |        |      |          |        |                    |  |
| FIELD ID                           | As                     | Ba                     | Cd       | Co      | Cr        | Cu      | Fe  | Hg     | Mn      | Ni     | Pb   | Sb       | Zn     | CALC. (mg CaCO3/L) |  |
| 23-027-SW-1                        | 0.96 JX                | 91.8                   | 2.57 U   | 9.7 U   | 6.97      | 1.55 U  | 102 | 0.12   | 4.08 UJ | 12.7 U | 3.23 | 30.7 UJX | 8.77   | 177                |  |
| 23-027-SW-2                        | 1.38 JX                | 98.4                   | 2.57 U   | 9.7 U   | 6.83 U    | 1.55 U  | 102 | 0.12 U | 4.08 UJ | 12.7 U | 1.47 | 30.7 UJX | 7.57 U | 188                |  |
| 23-027-SW-3                        | 0.96 U                 | 110                    | 2.57 U   | 9.7 U   | 6.83 U    | 2.47 J  | 99  | 0.12 U | 4.08 U  | 12.7 U | 0.72 | 30.7 U   | 8.17   | 203                |  |
| Wet Chemistry<br>Results in mg/l   |                        |                        |          |         |           |         |     |        |         |        |      |          |        |                    |  |
| FIELD ID                           | TOTAL DISSOLVED SOLIDS | TOTAL SUSPENDED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE | TSS |        |         |        |      |          |        |                    |  |
| 23-027-SW-1                        | 267                    | < 4                    | < 5.0    | 12      | < 0.05    | NR      | < 4 |        |         |        |      |          |        |                    |  |
| 23-027-SW-2                        | 247                    | < 4                    | < 5.0    | 14      | < 0.05    | NR      | < 4 |        |         |        |      |          |        |                    |  |
| 23-027-SW-3                        | 265                    | < 4                    | < 5.0    | 14      | < 0.05    | NR      | < 4 |        |         |        |      |          |        |                    |  |

**LEGEND**

SE1 - Downstream of tailings impoundment, approx. 100'.  
 SE2 - Between exposed and reclaimed pond, owned by Ronco. Downstream of shaft.  
 SE3 - At Ronco intake pond above Ronco tailings, downstream of placer tailings.  
 TP1 - Composite of subsamples TP1A, 1B, and 1C.  
 BACKGROUND - From the Vortex Mine (23-027-SS-1).

SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.  
 SW3 - Same as sample SE3.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>NE NE S31</u>                      | County: <u>Judith Basin</u>                  |
| Legal Description: <u>T 14N R 10E</u>                 | Section(s): <u>NE 1/4, NE 1/4, Sec. 31</u>   |
| Mining District: <u>Yogo</u>                          | Mine Type: <u>millsite/Unknown</u>           |
| Latitude: <u>N 46° 56' 07"</u>                        | Primary Drainage: <u>Yogo Creek</u>          |
| Longitude: <u>W 110° 29' 42"</u>                      | USGS Code: <u>10040103</u>                   |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Elk Creek</u>         |
| Quad: <u>Bandbox Mountain</u>                         | Date Investigated: <u>September 10, 1993</u> |
| Inspectors: <u>Bullock, S. Babits</u>                 | P.A. # <u>23-079</u>                         |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- The volume of tailings associated with this site was estimated to be approximately 650 cubic yards. The following elements were elevated at least three times background:

|                                |                                |
|--------------------------------|--------------------------------|
| Cobalt: 118 to 119 mg/kg       | Copper: 9780 to 11,000 mg/kg   |
| Iron: 184,000 to 196,000 mg/kg | Mercury: 0.178 to 0.203J mg/kg |
| Manganese: 1050J to 1070 mg/kg | Nickel: 91.8 to 97.5 mg/kg     |
| Lead: 32.1 mg/kg               | Zinc: 268 to 279 mg/kg         |
- The tailings impoundment was located in an intermittent drainage and was subject to washouts or erosion during low probability flood/runoff events.
- No waste rock was present on this site. Several small mines were present in the vicinity of the mill and were assumed to have been the source for the ore.
- The surface water samples collected in Elk Creek did not document an observed release of any element to Elk Creek and indicate that there were no significant contaminant sources upstream of the mill in the intermittent tributary. There were no MCL/MCLG exceedances or aquatic life criteria exceedances directly attributable to this site. Sediment sampling in Elk Creek did document observed releases of cobalt, iron, mercury, manganese, nickel, and zinc which were directly attributable to this site. These documented releases indicated that tailings were carried to Elk Creek during spring runoff or storm events.

**NE NE S31 PA# 23-079**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER-BULLOCK**  
**INVESTIGATION DATE: 9/10/93**

| SOLID MATRIX ANALYSES   |                   |                                   |                            |                                     |                     |                     |                     |                                     |                                     |               |               |               |               |                    |
|---|-------------------|-----------------------------------|----------------------------|-------------------------------------|---------------------|---------------------|---------------------|-------------------------------------|-------------------------------------|---------------|---------------|---------------|---------------|--------------------|
| Metals in soils<br>Results per dry weight basis   |                   |                                   |                            |                                     |                     |                     |                     |                                     |                                     |               |               |               |               |                    |
| FIELD ID  | As<br>(mg/Kg)     | Ba<br>(mg/Kg)                     | Cd<br>(mg/Kg)              | Co<br>(mg/Kg)                       | Cr<br>(mg/Kg)       | Cu<br>(mg/Kg)       | Fe<br>(mg/Kg)       | Hg<br>(mg/Kg)                       | Mn<br>(mg/Kg)                       | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
| 23-079-SE-1   | 34                | 193                               | 3.3 U                      | 54.2                                | 86                  | 2930                | 168000              | 0.189 J                             | 650                                 | 79.6          | 36.1          | 22.5 UJ       | 164           | NR                 |
| 23-079-SE-2   | 6.74              | 80.7                              | 1.1 U                      | 12.3                                | 36                  | 371                 | 25300               | 0.04 U                              | 209                                 | 29.8          | 15.4          | 7.5 UJ        | 46.9          | NR                 |
| 23-079-TP-1   | 9.95              | 113                               | 1.2 U                      | 119                                 | 30.7                | 9780                | 196000              | 0.203 J                             | 1070                                | 97.5          | 32.1          | 8 UJ          | 279           | NR                 |
| 23-079-TP-2   | 10.6              | 107                               | 1.1 U                      | 118                                 | 26.8                | 11000               | 184000              | 0.178                               | 1050 J                              | 91.8          | 22            | 7.5 UJ        | 268           | NR                 |
| BACKGROUND  | 14.1              | 155                               | 1.1 U                      | 3.29                                | 14.5                | 6.4                 | 12200               | 0.037 J                             | 330                                 | 11.6          | 9.65          | 7.34 UJ       | 44.6          | NR                 |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                   |                                   |                            |                                     |                     |                     |                     |                                     |                                     |               |               |               |               |                    |
| Acid/Base Accounting  |                   |                                   |                            |                                     |                     |                     |                     |                                     |                                     |               |               |               |               |                    |
| FIELD ID  | TOTAL SULFUR<br>% | TOTAL SULFUR ACID BASE<br>t/1000t | NEUTRAL POTENT.<br>t/1000t | SULFUR ACID BASE POTENT.<br>t/1000t | SULFATE SULFUR<br>% | PYRITIC SULFUR<br>% | ORGANIC SULFUR<br>% | PYRITIC SULFUR ACID BASE<br>t/1000t | SULFUR ACID BASE POTENT.<br>t/1000t |               |               |               |               |                    |
| 23-079-TP-1   | 0.58              | 18.1                              | 68.8                       | 50.7                                | <0.01               | 1.19                | 0.67                | 37.2                                | 31.6                                |               |               |               |               |                    |
| 23-079-TP-1DUP  | 0.59              | 18.4                              | 70.4                       | 52                                  | <0.01               | 1.16                | 0.69                | 36.2                                | 34.2                                |               |               |               |               |                    |
| 23-079-TP-2   | 0.65              | 20.3                              | 69.2                       | 48.8                                | <0.01               | 1.17                | 0.9                 | 36.6                                | 32.6                                |               |               |               |               |                    |

| WATER MATRIX ANALYSES   |                        |          |         |           |         |        |        |        |        |        |        |        |      |                                |
|---|------------------------|----------|---------|-----------|---------|--------|--------|--------|--------|--------|--------|--------|------|--------------------------------|
| Metals in Water<br>Results in ug/L  |                        |          |         |           |         |        |        |        |        |        |        |        |      |                                |
| FIELD ID  | As                     | Ba       | Cd      | Co        | Cr      | Cu     | Fe     | Hg     | Mn     | Ni     | Pb     | Sb     | Zn   | HARDNESS CALC.<br>(mg CaCO3/L) |
| 23-079-SW-1   | 0.96 U                 | 36.8     | 2.57 U  | 9.7 U     | 6.83 U  | 3.87 J | 37.1   | 0.12 U | 4.08 U | 12.7 U | 0.76   | 30.7 U | 13   | 149                            |
| 23-079-SW-2   | 1.33                   | 38.1     | 2.57 U  | 9.7 U     | 6.83 U  | 2.7 J  | 71.8   | 0.12 U | 4.08 U | 12.7 U | 0.72 U | 30.7 U | 13.1 | 128                            |
| 23-079-SW-3   | 0.96 U                 | 23       | 2.57 U  | 9.7 U     | 6.83 U  | 2.6 J  | 11.8 U | 0.12 U | 4.08 U | 12.7 U | 0.72 U | 30.7 U | 11.2 | 116                            |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                        |          |         |           |         |        |        |        |        |        |        |        |      |                                |
| Wet Chemistry<br>Results in mg/l  |                        |          |         |           |         |        |        |        |        |        |        |        |      |                                |
| FIELD ID  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |        |        |        |        |        |        |        |      |                                |
| 23-079-SW-1   | 189                    | < 5.0    | 10      | < 0.05    | NR      |        |        |        |        |        |        |        |      |                                |
| 23-079-SW-2   | 169                    | < 5.0    | 6       | < 0.05    | NR      |        |        |        |        |        |        |        |      |                                |
| 23-079-SW-3   | 154                    | < 5.0    | 10      | 0.06      | NR      |        |        |        |        |        |        |        |      |                                |

**LEGEND**

SE1 - Downstream Elk Creek.  
SE2 - Upstream Elk Creek.  
TP1 - Composite of subsamples TP1A, 1B, and 1C.  
TP2 - Composite of subsamples TP2A, 2B, and 2C.  
BACKGROUND - From the Vortex Mine (23-027-SS-1).  
TP1DUP- Duplicate of the 23-079-TP-1 sample.

SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.  
SW3 - Upstream intermittent tributary.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Davis Gulch II  
Legal Description: T 9N R 4W  
Mining District: Helena  
Latitude: N 46° 34' 16"  
Longitude: W 112° 02' 54"  
Land Status: Private  
Quad: Helena  
Inspectors: Bullock, Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Lewis and Clark  
Section(s): NW 1/4, SE 1/4, Sec. 1  
Mine Type: Hardrock/Unknown  
Primary Drainage: Tenmile  
USGS Code: 10030101  
Secondary Drainage: Dry Gulch (Davis  
Gulch)  
Date Investigated: August 19, 1993  
P.A. # 25-040

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was approximately 20 cubic yards. The following elements were elevated at least three times background:  
Mercury: 0.74J mg/kg  
Nickel: 63 mg/kg
- There were no adit discharges, springs, or seeps associated with this site.
- The site was within 100 feet of Dry Gulch, an intermittent drainage, but was isolated from this drainage by cultural features including a large berm. Due to the isolation of the source from the drainage, no sediment samples were collected.



**Davis Gulch II PA# 25-040**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/19/93**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 25-040-WR-1 | 18.3 J        | 50.5 J        | 0.8           | 22.5          | 27.6          | 17.5 J        | 13500 J       | 0.74 J        | 604 J         | 63            | 10.8 J        | 5.35 U        | 30.1 J        | NR                 |
| BACKGROUND  | 87 J          | 84.6          | 2.5           | 11.9          | 7.4 J         | 21 J          | 16200         | 0.053         | 1130          | 8 J           | 144 J         | 6 UJ          | 167           | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|----------------------|---|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 25-040-WR-1 | <0.01                | 0                                       | 365                           | 365                                       | <0.01                  | <0.01                  | <0.01                  | 0   | 365                                       |

**LEGEND**

WR1 - Composite of subsamples WR1A and 1B.  
BACKGROUND - From the Red Water Mine (25-007-SS-10).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Spring Hill Tailings</u>   | County: <u>Lewis and Clark</u>            |
| Legal Description: T <u>9N</u> R <u>4W</u>  | Section(s): <u>SE 1/4, SE 1/4, Sec. 4</u> |
| Mining District: <u>Helena</u>  | Mine Type: <u>Hardrock/Au</u>             |
| Latitude: <u>N 46° 33' 29"</u>  | Primary Drainage: <u>Tenmile Creek</u>    |
| Longitude: <u>W 112° 06' 22"</u>  | USGS Code: <u>10031101</u>                |
| Land Status: <u>Private/Public</u>  | Secondary Drainage: <u>Grizzly Gulch</u>  |
| Quad: <u>Helena</u>   | Date Investigated: <u>August 30, 1993</u> |
| Inspectors: <u>Tuesday, Flammang, Pierson</u>   | P.A. # <u>25-067</u>                      |
| Organization: <u>Pioneer Technical Services, Inc./ Thomas, Dean and Hoskins, Inc.</u> |   |

- The volume of tailings associated with this site was estimated to be approximately 378,500 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 485 to 4,800 mg/kg      Zinc: 302 mg/kg  
Iron: 182,000 mg/kg      Lead: 121J to 1,180J mg/kg
- Cyanide was present in TP-3 at 758 mg/kg.
- No flowing streams were observed on-site; consequently, no surface water or sediment samples were collected. However, a sample was collected (GW-1) from a spring located near the site which was used as a drinking water source. No MCL/MCLG exceedances were observed in the spring.
- The dam faces on TP-1 and TP-2 were steep and unstable, TP-3 was very steep and unstable; both were actively eroding. An adit located 300 feet west of TP-1 was currently open and potentially hazardous.

**Spring Hill Tailings PA# 25-067**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 08/30/93**

| SOLID MATRIX ANALYSES                           |                |                                     |                               |                                       |                  |                  |                  |                                       |                                       |            |            |            |            |                 |
|---|----------------|-------------------------------------|-------------------------------|---------------------------------------|------------------|------------------|------------------|---------------------------------------|---------------------------------------|------------|------------|------------|------------|-----------------|
| Metals in soils<br>Results per dry weight basis |                |                                     |                               |                                       |                  |                  |                  |                                       |                                       |            |            |            |            |                 |
| FIELD ID  | As (mg/Kg)     | Ba (mg/Kg)                          | Cd (mg/Kg)                    | Co (mg/Kg)                            | Cr (mg/Kg)       | Cu (mg/Kg)       | Fe (mg/Kg)       | Hg (mg/Kg)                            | Mn (mg/Kg)                            | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 25-067-TP-1A                                    | 711            | 54.2 JX                             | 3.3 J                         | 6.88                                  | 13               | 36.3             | 38400            | 0.109 JX                              | 328                                   | 10.4 J     | 97.4 J     | 6.7 UJ     | 196        | 3.1             |
| 25-067-TP-1B                                    | 485            | 58 JX                               | 2.5 J                         | 4.88                                  | 15.8             | 24.5             | 36700            | 0.064 JX                              | 337                                   | 7.11 J     | 80.2 J     | 6.81 UJ    | 182        | 0.426           |
| 25-067-TP-2A                                    | 707            | 55.9 JX                             | 2.2 J                         | 5.81                                  | 13.9             | 59.6             | 46400            | 0.118 JX                              | 323                                   | 11.9 J     | 124 J      | 6.46 UJ    | 164        | 7.15            |
| 25-067-TP-2B                                    | 887            | 89.7 JX                             | 2.8 J                         | 5.79                                  | 15.4             | 31.7             | 41100            | 0.192 JX                              | 410                                   | 7.74 J     | 121 J      | 6.71 UJ    | 195        | 2.63            |
| 25-067-TP-3                                     | 4800           | 44 JX                               | 2.1 J                         | 19.1                                  | 12.8             | 334              | 182000           | 0.3 JX                                | 152                                   | 10 J       | 1180 J     | 7.58 UJ    | 302        | 758             |
| BACKGROUND                                      | 27.1           | 165 JX                              | 1.3 J                         | 13.6                                  | 17.9             | 29.7             | 23300            | 0.071 JX                              | 672                                   | 17.9 J     | 36.3 J     | 6.98 UJ    | 76.4       | NR              |
| Acid/Base Accounting                            |                |                                     |                               |                                       |                  |                  |                  |                                       |                                       |            |            |            |            |                 |
| FIELD ID  | TOTAL SULFUR % | TOTAL SULFUR ACID BASE $\mu$ /1000t | NEUTRAL. POTENT. $\mu$ /1000t | SULFUR ACID BASE POTENT. $\mu$ /1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE $\mu$ /1000t | SULFUR ACID BASE POTENT. $\mu$ /1000t |            |            |            |            |                 |
| 25-067-TP-1A                                    | 1.39           | 43.4                                | 126                           | 82.8                                  | 0.88             | 0.28             | 0.23             | 8.75                                  | 117                                   |            |            |            |            |                 |
| 25-067-TP-1B                                    | 1.45           | 45.3                                | 173                           | 127                                   | 0.65             | 0.24             | 0.56             | 7.5                                   | 165                                   |            |            |            |            |                 |
| 25-067-TP-2A                                    | 2.02           | 63.1                                | 111                           | 48                                    | 1.24             | 0.35             | 0.43             | 10.9                                  | 100                                   |            |            |            |            |                 |
| 25-067-TP-2B                                    | 1.48           | 46.2                                | 184                           | 138                                   | 0.38             | 0.49             | 0.61             | 15.3                                  | 168                                   |            |            |            |            |                 |
| 25-067-TP-3DUP                                  | 18             | 561                                 | -36                           | -597                                  | <0.01            | 9.71             | 13.9             | 303                                   | -339                                  |            |            |            |            |                 |
| 25-067-TP-3                                     | 17.9           | 560                                 | -35                           | -595                                  | <0.01            | 9.78             | 13.9             | 306                                   | -341                                  |            |            |            |            |                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

| WATER MATRIX ANALYSES   |                        |          |         |           |         |         |   |        |        |        |        |        |                 |                |  |
|---|------------------------|----------|---------|-----------|---------|---------|---|--------|--------|--------|--------|--------|-----------------|----------------|--|
| Metals in Water<br>Results in ug/L  |                        |          |         |           |         |         |   |        |        |        |        |        |                 |                |  |
| FIELD ID  | As                     | Ba       | Cd      | Co        | Cr      | Cu      | Fe  | Hg     | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |  |
| 25-067-GW-1   | 14.1 J                 | 2.5      | 2.57 U  | 9.7 U     | 10.6 J  | 5.1 J   | 17.2 JX   | 0.12 U | 4.08 U | 12.7 U | 2.89 J | 30.7 U | 7.57 U          | 205            |  |
| 25-067-GW-2   | 23 J                   | 2.01 U   | 2.57 U  | 9.7 U     | 8.83 J  | 17.6 J  | 15.1 JX   | 0.15   | 4.08 U | 12.7 U | 4.9 J  | 30.7 U | 10.4            | 212            |  |
| 25-067-GW-3   | 4.42 J                 | 2.01 U   | 2.57 U  | 9.7 U     | 6.83 U  | 6.8 J   | 11.8 UX   | 0.12 U | 4.08 U | 12.7 U | 1.7 J  | 30.7 U | 7.57 U          | 0.3            |  |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                        |          |         |           |         |         |   |        |        |        |        |        |                 |                |  |
| Wet Chemistry<br>Results in mg/l  |                        |          |         |           |         |         |   |        |        |        |        |        |                 |                |  |
| FIELD I.D.  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE | LEGEND  |   |        |        |        |        |        |                 |                |  |
| 25-067-GW-1   | 265                    | <        | 5       | 52        | 0.31    | < 0.005 | TP1A - Composite of subsamples TP1A-1, 1A-B, 1B-A, 1C-A, and 1C-B.        |        |        |        |        |        |                 |                | GW1 - Spring which supplies residents. |
| 25-067-GW-2   | NR                     | NR       | NR      | NR        | NR      | < 0.005 | TP1B - Composite of subsamples TP1AA-C, 1A-D, 1A-E, 1B-C, 1B-B, and 1C-C. |        |        |        |        |        |                 |                | GW2 - Duplicate of sample GW1.         |
| 25-067-GW-3   | NR                     | NR       | NR      | NR        | NR      | < 0.005 | TP2A - Composite of subsamples TP2A-A, 2A-B, 2A-C, 2B-A, and 2B-B.        |        |        |        |        |        |                 |                | GW3 - QA Blank.                        |
|   |                        |          |         |           |         |         | TP3 - Composite of subsample TP3A, 3B, and 3C.                            |        |        |        |        |        |                 |                |  |
|   |                        |          |         |           |         |         | BACKGROUND - From the Franklin Mine (25-339-SS-1).                        |        |        |        |        |        |                 |                |  |
|   |                        |          |         |           |         |         | TP3DUP - Duplicate of sample 25-067-TP-3.                                 |        |        |        |        |        |                 |                |  |

**LEGEND**

TP1A - Composite of subsamples TP1A-1, 1A-B, 1B-A, 1C-A, and 1C-B.  
 TP1B - Composite of subsamples TP1AA-C, 1A-D, 1A-E, 1B-C, 1B-B, and 1C-C.  
 TP2A - Composite of subsamples TP2A-A, 2A-B, 2A-C, 2B-A, and 2B-B.  
 TP3 - Composite of subsample TP3A, 3B, and 3C.  
 BACKGROUND - From the Franklin Mine (25-339-SS-1).  
 TP3DUP - Duplicate of sample 25-067-TP-3.

GW1 - Spring which supplies residents.  
 GW2 - Duplicate of sample GW1.  
 GW3 - QA Blank.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Lady Luck  
Legal Description: T 9N R 4W  
Mining District: Helena  
Latitude: N 46° 33' 06"  
Longitude: W 112° 04' 55"  
Land Status: Public  
Quad: Helena  
Inspectors: Tuesday, Flammang/Pierson  
Organization: Pioneer Technical Services,  
Inc./ Thomas, Dean and Hoskins, Inc.

County: Lewis and Clark  
Section(s): NE 1/4, Sec. 10; NW 1/4, Sec. 11  
Mine Type: Hardrock/Au  
Primary Drainage: Tenmile Creek  
USGS Code: 10030101  
Secondary Drainage: Orofino Creek  
Date Investigated: August 30, 1993  
P.A. # 25-073

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be approximately 10,145 cubic yards. The following element were elevated at least three times background:  
Mercury: 0.456JX mg/kg  
  
Mercury was the only element which was elevated above background.
- No water was observed on-site; consequently, no surface water or sediment samples were collected. Also, no groundwater samples were collected.
- Adit #5 was open and was potentially hazardous.



**Lady Luck PA# 25-073**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 08/30/93**

| SOLID MATRIX ANALYSES   |                      |   |                               |   |                        |                        |                        |   |   |  |               |               |               |                    |
|---|----------------------|---|-------------------------------|---|------------------------|------------------------|------------------------|---|---|--|---------------|---------------|---------------|--------------------|
| Metals in soils<br>Results per dry weight basis   |                      |   |                               |   |                        |                        |                        |   |   |  |               |               |               |                    |
| FIELD ID  | As<br>(mg/Kg)        | Ba<br>(mg/Kg)                           | Cd<br>(mg/Kg)                 | Co<br>(mg/Kg)                             | Cr<br>(mg/Kg)          | Cu<br>(mg/Kg)          | Fe<br>(mg/Kg)          | Hg<br>(mg/Kg)                             | Mn<br>(mg/Kg)                             | Ni<br>(mg/Kg)  | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
| 25-073-WR-1   | 18.8 J               | 0.244 U                                 | 1 U                           | 1.11 U                                    | 6.72 J                 | 13.3 JX                | 4590                   | 0.456 JX                                  | 200                                       | 6.24 J   | 7.28 U        | 7.03 UJ       | 76.6 J        | NR                 |
| BACKGROUND  | 27.1                 | 165 JX                                  | 1.3 J                         | 13.6                                      | 17.9                   | 29.7                   | 23300                  | 0.071 JX                                  | 672                                       | 17.9 J   | 36.3 J        | 6.98 UJ       | 76.4          | NR                 |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                      |   |                               |   |                        |                        |                        |   |   |  |               |               |               |                    |
| Acid/Base Accounting  |                      |   |                               |   |                        |                        |                        |   |   |  |               |               |               |                    |
| FIELD ID  | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | LEGEND   |               |               |               |                    |
| 25-073-WR-1   | <0.01                | 0                                       | 852                           | 852                                       | <0.01                  | <0.01                  | 0.01                   | 0   | 852                                       | WR1 - Composite of subsamples WR3 and 4.<br>BACKGROUND - From the Franklin Mine (25-339-SS-1). |               |               |               |                    |

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Mother Lode  
Legal Description: T 10N R 3W  
Mining District: Helena  
Latitude: N 46° 37' 00"  
Longitude: W 111° 55' 15"  
Land Status: Private/Public  
Quad: East Helena  
Inspectors: Tuesday, Flammang/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Lewis and Clark  
Section(s): Sec. 23  
Mine Type: None  
Primary Drainage: Prickly Pear Creek  
USGS Code: 10030101  
Secondary Drainage: Prickley Pear Creek  
Date: August 31, 1993  
P.A. # 25-363

- This site was a silver film reprocessing facility and not a mining site. The site was remediated in 1984 by EPA. No samples were collected during the investigation; the site should be removed from the inventory.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Seven-Up Pete  
Legal Description: T 14N R 7W  
Mining District: Lincoln  
Latitude: N 46° 57' 30"  
Longitude: W 112° 30' 00"  
Land Status: Private  
Quad: Swede Gulch  
Inspectors: M. Babits, S. Babits/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Lewis and Clark  
Section(s): NE 1/4, Sec. 29  
Mine Type: Hardrock/Unknown  
Primary Drainage: Blackfoot River  
USGS Code: 17010203  
Secondary Drainage: Seven-Up Pete Creek  
Date Investigated: September 7, 1993  
P.A. # 25-020

- An extremely small volume of tailings was identified at this site; no samples were collected.
- The volume of waste rock associated with this site was estimated to be approximately 20,800 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 71.1J to 309J mg/kg      Mercury: 0.49J to 0.826J mg/kg
- Three discharging adits were identified at the site, one of which directly entered surface water. No MCLs were exceeded in a sample of this discharge; however, the chronic aquatic life criteria for cadmium and mercury were exceeded. The discharge pH measurement was 8.36.
- An unnamed tributary to Seven Up Creek flowed through the center of the site (adjacent to several waste rock piles). Surface water and sediment samples were collected upstream and downstream from the site. No MCLs were exceeded; however, chronic aquatic life criteria were exceeded for mercury both upstream and downstream from the site.
- An observed release to the unnamed tributary (sediment) was documented for arsenic.
- One potentially hazardous open adit and numerous hazardous structures were identified at the site.



**Seven Up Pete PA# 25-020**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 09/07/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 25-020-SE-1 | 26.3 J     | 290 J      | 1.2 U      | 6.5        | 11.9       | 23.7 J     | 14000      | 0.238 J    | 1310 J     | 34.2 J     | 22.2 J     | 14.3 U     | 132 J      | NR              |
| 25-020-SE-2 | 185 J      | 220 J      | 0.6        | 15.7       | 14.9       | 52.3 J     | 25000      | 0.085 J    | 462 J      | 61.8 J     | 10.1 J     | 5.79 U     | 61.6 J     | NR              |
| 25-020-WR-1 | 309 J      | 180 J      | 0.6 U      | 3.73       | 6.27       | 36.4 J     | 25000      | 0.49 J     | 93.3 J     | 10.9 J     | 27.3 J     | 6.99 U     | 51 J       | NR              |
| 25-020-WR-2 | 71.1 J     | 228 J      | 1.0 U      | 6.73       | 4.47       | 21.6 J     | 16400      | 0.829 J    | 292 J      | 18.2 J     | 35.1 J     | 5.9 U      | 55.7 J     | NR              |
| BACKGROUND  | 19.5 J     | 168 J      | 1.0 U      | 9.67 J     | 36.5 J     | 228 JX     | 12800      | 0.033 UX   | 468        | 30.4 J     | 34.4       | 6.95 UJ    | 66.9 J     | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 25-020-WR-1 | 0.43           | 13.4                           | 1.3                     | -12                              | 0.23             | 0.05             | 0.15             | 1.56                             | -0.26                            |
| 25-020-WR-2 | 0.17           | 5.31                           | 0.54                    | -4.8                             | 0.09             | 0.02             | 0.06             | 0.62                             | -0.09                            |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co    | Cr     | Cu     | Fe   | Hg       | Mn   | Ni      | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|------|--------|-------|--------|--------|------|----------|------|---------|------|--------|-----------------|----------------|
| 25-020-SW-1 | 3.97 | 202  | 2.57 U | 9.7 U | 6.83 U | 11 J   | 1300 | 0.19 JX  | 130  | 17.1 JX | 3.4  | 30.7 U | 16.6 J          | 100            |
| 25-020-SW-2 | 5.41 | 128  | 2.93 J | 9.7 U | 6.83 U | 11.7 J | 395  | 0.12 UJX | 43.1 | 25.3 JX | 3.8  | 30.7 U | 21.4 J          | 130            |
| 25-020-SW-5 | 9.14 | 29.1 | 4.6 J  | 9.7 U | 6.83 U | 6.17 J | 256  | 0.15 JX  | 87.5 | 24.7 JX | 2.17 | 30.7 U | 36.4 J          | 148            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 25-020-SW-1 | 191                    | < 5.0    | 12      | 0.22      | NR      |
| 25-020-SW-2 | 256                    | < 5.0    | 42      | < 0.05    | NR      |
| 25-020-SW-5 | 276                    | < 5.0    | 47      | 0.37      | NR      |

**LEGEND**

SE1 - 200 feet upgradient in unnamed tributary.

SE2 - Downgradient at toe of waste rock dump 1 in unnamed tributary.

WR1 - Composite of WR1A and 1B.

WR2 - Sample of the WR2A subsample.

BACKGROUND - From the Swansea Tailings (25-208-SS-1).

SW1 - Same as sample SE1.

SW2 - Same as sample SE2.

SW5 - Adit discharge at waste rock dump 2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |   |
|--|---|
| Mine/Site Name: <u>Blackfoot Tailings</u>  | County: <u>Lewis and Clark</u>                    |
| Legal Description: <u>T 14N R 9W</u>   | Section(s): <u>E 1/2, NE 1/4, NE1/4, Sec. 29</u>  |
| Mining District: <u>Lincoln</u>  | Mine Type: <u>Tailings Dump (Millsite)</u>        |
| Latitude: <u>N 46° 56' 33"</u>   | Primary Drainage: <u>Blackfoot River</u>          |
| Longitude: <u>W 112° 45' 10"</u>   | USGS Code: <u>17010203</u>                        |
| Land Status: <u>Public</u>   | Secondary Drainage: <u>Lincoln Gulch</u>          |
| Quad: <u>Moose Creek</u>   | Date Investigated: <u>September 7 and 8, 1993</u> |
| Inspectors: <u>M. Babits, S. Babits/Pierson</u>                                      | P.A. # <u>25-322</u>                              |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |   |

- The volume of tailings associated with this site was estimated to be approximately 5,000 cubic yards. The following elements were elevated at least three times background:

|                                |                               |
|--------------------------------|-------------------------------|
| Arsenic: 33.7J to 402J mg/kg   | Cadmium: 0.9 to 114 mg/kg     |
| Cobalt: 23.6 to 54.3 mg/kg     | Chromium: 15.2 to 45.9 mg/kg  |
| Copper: 57.9 to 13,400 mg/kg   | Iron: 27,900 to 205,000 mg/kg |
| Mercury: 0.104J to 2.52J mg/kg | Nickel: 18.4J to 57.9J mg/kg  |
| Lead: 48J to 8,700J mg/kg      | Zinc: 157J to 10,500J mg/kg   |
- No waste rock was observed at this site during the investigation.
- One upgradient (GW-5) and two downgradient (GW-1 and 6) groundwater samples were collected during the investigation. Observed releases to groundwater were documented for arsenic, cadmium, chromium, copper, mercury, nickel, lead, and zinc. MCLs were exceeded for copper, chromium, mercury, and nickel in the downgradient sample, which were attributable to the site.
- No surface water was observed on site. The nearest surface water, the Blackfoot River, was located approximately 180 feet east of the site. No surface water samples were collected due to likely excessive dilution.
- No hazardous mine openings were identified at the site.

**Blackfoot Tailings PA# 25-322**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/07/83**

| Metals in soils      |                |                               | Results per dry weight basis (mg/kg) |                                 |                  |                 |                  |                                |                                 |   |         |         |                          |                       |   |  | SOLID MATRIX ANALYSES |  |  |  |  |  |  |  |  |  |  |  |  |  |
|----------------------|----------------|-------------------------------|--------------------------------------|---------------------------------|------------------|-----------------|------------------|--------------------------------|---------------------------------|---|---------|---------|--------------------------|-----------------------|---|--|-----------------------|--|--|--|--|--|--|--|--|--|--|--|--|--|
| FIELD ID             | As             | Ba                            | Cd                                   | Co                              | Cr               | Cu              | Fe               | Hg                             | Mn                              | Ni                                      | Pb      | Sb      | Zn                       | CYANIDE               |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1A-A        | 87.2 J         | 74.6 J                        | 7.8                                  | 6.43                            | 3.89             | 163 J           | 45100            | 2.14 J                         | 15.2 J                          | 8.35 J                                  | 4360 J  | 6.02 U  | 1330 J                   | 0.299 U               |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1A-B        | 156 J          | 69.5 J                        | 0.9                                  | 4.3                             | 3.9              | 57.9 J          | 27500.0          | 0.2 J                          | 27.6 J                          | 8.0 J                                   | 117.0 J | 8.0 U   | 200.0 J                  | 0.328 U               |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1A-C        | 84.6 J         | 93.9 J                        | 3.0                                  | 4.17                            | 8.43             | 102 J           | 34700            | 0.144 J                        | 58 J                            | 10.3 J                                  | 253 J   | 5.53 U  | 497 J                    | 0.311 U               |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1A-D        | 112 J          | 203 J                         | 114.0                                | 4.98                            | 38.8             | 4440 J          | 27900            | 0.484 J                        | 56.4 J                          | 19.8 J                                  | 21.3 J  | 9.44 U  | 1340 J                   | 0.396 U               |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1A-E        | 14.8 J         | 94.5 J                        | 2.0                                  | 9.12                            | 9.84             | 118 J           | 13000            | 0.0761 J                       | 59.7 J                          | 27.2 J                                  | 33 J    | 5.96 U  | 1930 J                   | 0.327 U               |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1B-A        | 70 J           | 274 J                         | 4.3                                  | 1.71 U                          | 1.75             | 617 J           | 17600            | 0.837 J                        | 16.2 J                          | 2.23 U                                  | 8700 J  | 5.4 U   | 842 J                    | 0.289 U               |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1B-B        | 79.2 J         | 52.9 J                        | 1.3                                  | 2.51                            | 3.59             | 58.9 J          | 28200            | 0.08082 J                      | 33.7 J                          | 5.84 J                                  | 120 J   | 5.65 U  | 157 J                    | 0.302 U               |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1B-C        | 258 J          | 163 J                         | 9.9                                  | 5.73                            | 20.5             | 273 J           | 52100            | 0.263 J                        | 113 J                           | 18.6 J                                  | 119 J   | 7.16 U  | 1140 J                   | 0.317 U               |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1B-D        | 33.7 J         | 225 J                         | 70.1                                 | 12.3                            | 19.3             | 338 J           | 21400            | 0.06884 J                      | 275 J                           | 44.4 J                                  | 48 J    | 10.8 U  | 7380 J                   | 0.43 U                |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1B-E        | 16.9 J         | 93.7 J                        | 17.8                                 | 4.93                            | 15.2             | 802 J           | 14600            | 0.0761 J                       | 130 J                           | 14.5 J                                  | 74 J    | 7.78 U  | 1240 J                   | 0.309 U               |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1C-A        | 402 J          | 51.2 J                        | 21.5                                 | 54.3                            | 2.97             | 243 J           | 205000           | 0.03165 UJ                     | 60.1 J                          | 57.9 J                                  | 3830 J  | 5.66 U  | 2970 J                   | 0.307 U               |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1C-B        | 338 J          | 45.7 J                        | 4.5                                  | 4.92                            | 30.1             | 483 J           | 53100            | 0.369 J                        | 108 J                           | 9.6 J                                   | 45.9 J  | 6.33 U  | 758 J                    | 0.323 U               |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1C-C        | 108 J          | 144 J                         | 40.4                                 | 13.8                            | 27.1             | 2080 J          | 82400            | 0.373 J                        | 282 J                           | 23 J                                    | 206 J   | 8.37 U  | 1860 J                   | 0.411 U               |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1C-D        | 49.4 J         | 236 J                         | 61.9                                 | 13.2                            | 20.4             | 205 J           | 21300            | 0.104 J                        | 306 J                           | 40.7 J                                  | 123 J   | 8.25    | 10500 J                  | 0.371 U               |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1C-E        | 14.2 J         | 120 J                         | 3.4                                  | 6.35                            | 11.7             | 41.4 J          | 15400            | 0.04215 J                      | 149 J                           | 18.4 J                                  | 34.8 J  | 7.77 U  | 2380 J                   | 0.34 U                |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1D-A        | 97 J           | 292 J                         | 2.5                                  | 6.29                            | 17.3             | 370 J           | 84000            | 0.59 J                         | 431 J                           | 12.6 J                                  | 4950 J  | 7.39 U  | 663 J                    | 0.387 U               |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1D-B        | 17.8 J         | 183                           | 7.1                                  | 23.6                            | 13.3             | 91.1            | 9990             | 0.146 J                        | 547                             | 37.9                                    | 23.7    | 8.96 UJ | 5590 J                   | 0.39 U                |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1D-C        | 5.97 J         | 96.7                          | 0.6 U                                | 6.28                            | 7.2              | 36.1            | 8610             | 0.101 J                        | 731                             | 8.46                                    | 19.3    | 6.63 UJ | 79.2 J                   | 0.319 U               |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1E-A        | 56.5 J         | 115                           | 3.0                                  | 2.8                             | 1.6 U            | 21.5            | 13800            | 2.52 J                         | 6.66                            | 2.97 U                                  | 2770    | 7.19 UJ | 522 J                    | 0.31 U                |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1E-B        | 123 J          | 74.3                          | 2.7                                  | 5.04                            | 8.71             | 143             | 37000            | 0.08243 J                      | 117                             | 6.97                                    | 143     | 7.02 UJ | 316 J                    | 0.363 U               |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1E-C        | 31.1 J         | 191                           | 11.1                                 | 10.7                            | 45.9             | 13400           | 15600            | 0.141 J                        | 101                             | 18.5                                    | 32.4    | 9.26 UJ | 507 J                    | 0.385 U               |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1E-D        | 14.1 J         | 170                           | 63.9                                 | 6.28                            | 10.5             | 2030            | 11700            | 0.04547 J                      | 85.6                            | 14.5                                    | 105     | 6.39 UJ | 691 J                    | 0.639                 |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1F-A        | 114 J          | 130                           | 7.4                                  | 4.2                             | 1.95             | 200             | 38300            | 0.78 J                         | 64.7                            | 2.9                                     | 4310    | 5.38 UJ | 1080 J                   | 0.652                 |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| BACKGROUND           | 10.9 J         | 263                           | 0.5 U                                | 6.96                            | 4.52             | 14.9            | 9170             | 0.03401 U                      | 1100                            | 5.71                                    | 16      | 6.32 UJ | 44.1 J                   | NR                    |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Acid/Base Accounting |                |                               |                                      |                                 |                  |                 |                  |                                |                                 |   |         |         |                          |                       | U- Not Detected, J- Estimated Quantity, X- Outlier for Accuracy or Precision, NR- Not Requested |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| FIELD ID             | TOTAL SULFUR % | TOTAL SULFUR ACID BASE U/1000 | NEUTRAL POTENT. U/1000               | SULFUR ACID BASE POTENT. U/1000 | SULFATE SULFUR % | PHYTIC SULFUR % | ORGANIC SULFUR % | PHYTIC SULFUR ACID BASE U/1000 | SULFUR ACID BASE POTENT. U/1000 | Mechanical Analysis & % Coarse Material |         |         | Cation Exchange Capacity |                       |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                      |                |                               |                                      |                                 |                  |                 |                  |                                |                                 | % Clay                                  | % Sand  | % Silt  | % Coarse Material (>2mm) | milliequivalents/100g |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1A-A        | 6.12           | 191                           | -7.95                                | -199                            | 1.41             | 3.61            | 1.1              | 113                            | -121                            | 12                                      | 57      | 31.0    | 0                        | 4.01                  |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1A-B        | 1.09           | 34.1                          | -10.8                                | -44.9                           | 0.9              | 0.05            | 0.14             | 1.56                           | -12.4                           | 13                                      | 61.0    | 26.0    | 0                        | 1.84                  |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1A-C        | 1.15           | 35.9                          | -11.8                                | -47.7                           | 0.95             | 0.06            | 0.14             | 1.87                           | -13.6                           | 15                                      | 46      | 39.0    | 0                        | 3.72                  |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1A-D        | 1.89           | 59                            | -37.2                                | -96.3                           | 1.71             | 0.07            | 0.11             | 2.19                           | -39.4                           | 6                                       | 50      | 44.0    | 0                        | <0.001                |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1A-E        | 1.55           | 48.4                          | -15.3                                | -63.8                           | 1.11             | 0.3             | 0.14             | 9.37                           | -24.7                           | 8                                       | 56      | 36.0    | 0                        | 5.04                  |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1C-A        | 26.9           | 839                           | -9.72                                | -849                            | 0.7              | 15.1            | 11               | 473                            | -482                            | 7                                       | 52      | 40      | 0                        | 1.99                  |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1C-B        | 2.15           | 67.2                          | -19.7                                | 86.9                            | 2                | 0.04            | 0.11             | 1.25                           | -21                             | 5                                       | 31      | 64      | 0                        | 3.44                  |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1C-C        | 1.94           | 60.6                          | -29                                  | -89.6                           | 1.42             | 0.26            | 0.26             | 8.12                           | -37.2                           | 39                                      | 25      | 36      | 0                        | 11                    |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1C-D        | 2.08           | 65                            | -39.3                                | -104                            | 1.72             | 0.13            | 0.23             | 4.06                           | -43.4                           | 6                                       | 54      | 40      | 0                        | <0.001                |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1C-E        | 1.03           | 32.2                          | -15.8                                | -48                             | 0.89             | 0.05            | 0.09             | 1.56                           | -17.4                           | 5                                       | 65      | 30      | 0                        | 6.55                  |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-322-TP1A-C-DUP    | 1.13           | 35.3                          | -11.4                                | -46.7                           | 0.94             | 0.06            | 0.13             | 1.87                           | -13.3                           |   |         |         |                          |                       |   |  |                       |  |  |  |  |  |  |  |  |  |  |  |  |  |

U - Not Detected, J - Estimated Quantity, X - Outlier for Accuracy or Precision, NR - Not Requested

| Acid/Base Accounting |                | Sulfur                        |                        |                                 |                  |                  |                  |                                 |                                 |        |        | Mechanical Analysis & % Coarse Material |                          |                       | Cation Exchange Capacity |  |
|----------------------|----------------|-------------------------------|------------------------|---------------------------------|------------------|------------------|------------------|---------------------------------|---------------------------------|--------|--------|---|--------------------------|-----------------------|--------------------------|--|
| FIELD ID             | TOTAL SULFUR % | TOTAL SULFUR ACID BASE U/1000 | NEUTRAL POTENT. U/1000 | SULFUR ACID BASE POTENT. U/1000 | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE U/1000 | SULFUR ACID BASE POTENT. U/1000 | % Clay | % Sand | % Silt                                  | % Coarse Material (>2mm) | milliequivalents/100g |                          |  |
| 25-322-TP1A-A        | 6.12           | 191                           | -7.95                  | -199                            | 1.41             | 3.61             | 1.1              | 113                             | -121                            | 12     | 57     | 31.0                                    | 0                        | 4.01                  |                          |  |
| 25-322-TP1A-B        | 1.09           | 34.1                          | -10.8                  | -44.9                           | 0.9              | 0.05             | 0.14             | 1.56                            | -12.4                           | 13     | 61.0   | 26.0                                    | 0                        | 1.84                  |                          |  |
| 25-322-TP1A-C        | 1.15           | 35.9                          | -11.8                  | -47.7                           | 0.95             | 0.06             | 0.14             | 1.87                            | -13.6                           | 15     | 46     | 39.0                                    | 0                        | 3.72                  |                          |  |
| 25-322-TP1A-D        | 1.89           | 59                            | -37.2                  | -96.3                           | 1.71             | 0.07             | 0.11             | 2.19                            | -39.4                           | 6      | 50     | 44.0                                    | 0                        | <0.001                |                          |  |
| 25-322-TP1A-E        | 1.55           | 48.4                          | -15.3                  | -63.8                           | 1.11             | 0.3              | 0.14             | 9.37                            | -24.7                           | 8      | 56     | 36.0                                    | 0                        | 5.04                  |                          |  |
| 25-322-TP1C-A        | 26.9           | 839                           | -9.72                  | -849                            | 0.7              | 15.1             | 11               | 473                             | -482                            | 7      | 52     | 40                                      | 0                        | 1.99                  |                          |  |
| 25-322-TP1C-B        | 2.15           | 67.2                          | -19.7                  | -86.9                           | 2                | 0.04             | 0.11             | 1.25                            | -21                             | 5      | 31     | 64                                      | 0                        | 3.44                  |                          |  |
| 25-322-TP1C-C        | 1.94           | 60.6                          | -29                    | -89.6                           | 1.42             | 0.26             | 0.26             | 8.12                            | -37.2                           | 39     | 25     | 36                                      | 0                        | 11                    |                          |  |
| 25-322-TP1C-D        | 2.08           | 65                            | -39.3                  | -104                            | 1.72             | 0.13             | 0.23             | 4.06                            | -43.4                           | 6      | 54     | 40                                      | 0                        | <0.001                |                          |  |
| 25-322-TP1C-E        | 1.03           | 32.2                          | -15.8                  | -48                             | 0.89             | 0.05             | 0.09             | 1.56                            | -17.4                           | 5      | 65     | 30                                      | 0                        | 6.55                  |                          |  |
| 25-322-TP1A-C-DUP    | 1.13           | 35.3                          | -11.4                  | -46.7                           | 0.94             | 0.06             | 0.13             | 1.87                            | -13.3                           |        |        |   |                          |                       |                          |  |

| Metals in Water |         | Results in ug/L |        |       |        |        |        |         |        |        |       |          |         |                       |  | WATER MATRIX ANALYSES |  |
|-----------------|---------|-----------------|--------|-------|--------|--------|--------|---------|--------|--------|-------|----------|---------|-----------------------|--|-----------------------|--|
| FIELD ID        | As      | Ba              | Cd     | Co    | Cr     | Cu     | Fe     | Hg      | Mn     | Ni     | Pb    | Sb       | Zn      | CALC.<br>(mg CaCO3/L) |  |                       |  |
| 25-322-GW-1     | 633     | 6360            | 440 J  | 153   | 312    | 7570 J | 474000 | 5.44 JX | 15300  | 357 JX | 26900 | 30.7 U   | 33100 J | 897                   |  |                       |  |
| 25-322-GW-1(D)  | 5.72    | 7.23            | 29.1 J | 41.2  | 6.83 U | 2.8 J  | 6840   | 0.12 U  | 10500  | 48.7   | 6.76  | 30.7 U   | 8000    | 416                   |  |                       |  |
| 25-322-GW-5     | 141 JX  | 591             | 10.8   | 92.1  | 79.2   | 567    | 217000 | 0.12 U  | 8850   | 95.3   | 27.2  | 30.7 UJX | 540     | 290                   |  |                       |  |
| 25-322-GW-5(D)  | 0.96 U  | 17.9            | 2.57 U | 9.7 U | 6.83 U | 2.13 J | 22.3   | 0.12 U  | 57.7   | 12.7 U | 0.78  | 30.7 U   | 19      | 152                   |  |                       |  |
| 25-322-GW-6     | 17.4 JX | 163             | 2.57 U | 9.7 U | 6.83 U | 13.1   | 2300   | 0.16    | 949    | 12.7 U | 3.1   | 30.7 UJX | 43.2    | 174                   |  |                       |  |
| 25-322-GW-6(D)  | 4.4     | 92              | 2.57 U | 9.7 U | 6.83 U | 3.07 J | 11.8 U | 0.12 U  | 4.08 U | 12.7 U | 0.89  | 30.7 U   | 28.8    | 200                   |  |                       |  |

U - Not Detected, J - Estimated Quantity, X - Outlier for Accuracy or Precision, NR - Not Requested

| Wet Chemistry Results in mg/L |                        | Sulfur   |         |           |         |  |  |  |  |  |  | LEGEND |  |  |  |  |
|-------------------------------|------------------------|----------|---------|-----------|---------|--|--|--|--|--|--|--------|--|--|--|--|
| FIELD ID                      | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |  |  |  |  |  |  |        |  |  |  |  |
| 25-322-GW-1                   | 766                    | 18.0     | 410     | 0.17      | 0.008   |  |  |  |  |  |  |        |  |  |  |  |
| 25-322-GW-5                   | 210                    | < 5.0    | 5.0     | 0.2       | < 0.005 |  |  |  |  |  |  |        |  |  |  |  |
| 25-322-GW-6                   | 236                    | < 5.0    | < 5.0   | 0.13      | < 0.005 |  |  |  |  |  |  |        |  |  |  |  |

TP1AA - S. end of pond 0'-3'; green/gray medium grained dry sand.  
 TP1AB - 3'-3'; brown medium grained partially saturated sand.  
 TP1AC - 5'-6'; dark brown/black clay and brown flowing saturated sand.  
 TP1AD - 6'-7'; dark brown to black loam.  
 TP1AE - 7'-8'; dark purple, medium grained sand to gravel, saturated.  
 TP1BA - 50' N. of TP1A borehole 0'-3'; tan sand.  
 TP1BB - 3'-5'; orange sand with clay layers, partially saturated.  
 TP1BC - 5'-7'; brown dry clay.  
 TP1BD - 7'-10'; dark brown loam.  
 TP1BE - 10'; dark purple sand.

TP1CA - 66' North of TP1B borehole, gray sand with clay.  
 TP1CB - 1.5'-2'; orange sand.  
 TP1CD - 3'-4'; dark brown loam.  
 TP1CE - 4'; dark purple sand.  
 TP1DA - NE 1/4 of TP11 borehole; orange and gray clay.  
 TP1DB - 1.5'-2.5'; dark brown loam.  
 TP1DC - 2.5'; dark purple sand.  
 TP1EA - 25' West of TP1B borehole, 2'-1.5'; gray sand.  
 TP1EB - 1.5'-4'; Orange sand to clay.  
 TP1EC - 4'-4.2'; dark brown loam.  
 TP1ED - 4.2'; dark purple sand.  
 TP1FA - 25' East of TP1B borehole, 0-1.2'; gray sand.  
 TP1ACDUP - Duplicate.  
 GW1 - N. end of site; SWL 2.9' bgs and TD 5.7' bgs. (T-2).  
 GW1D - Sample GW1 for Total Dissolved Metals.  
 GW5 - On drill pad behind chimney west of site (#36), SWL 7.32' and TD 33 bgs.  
 GW5D - Sample GW5 for Total Dissolved Metals.  
 GW6 - Btm Blackfoot R. & Hwy 200 E., of site; SWL 3.79' and TD 37 bgs. (MFW-E)  
 GW6D - Sample GW6 for Total Dissolved Metals.  
 BACKGROUND - Above mine. From Blackfoot Tailings (25-322-SS-1)



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Bald Mountain  
Legal Description: T 12N R 6W  
Mining District: Marysville  
Latitude: N 46° 44' 55"  
Longitude: W 112° 19' 15"  
Land Status: Private  
Quad: Greenhorn Mountain  
Inspectors: Babits, Flammang, Lasher  
Organization: Pioneer Technical Services, Inc.

County: Lewis and Clark  
Section(s): NE 1/4, SW 1/4, Sec. 35  
Mine Type: Hardrock/Au, Ag  
Primary Drainage: Silver Creek  
USGS Code: 10030101  
Secondary Drainage: Jennies Fork  
Date Investigated: August 19, 1993  
P.A. # 25-061

- The volume of tailings associated with this site was estimated to be approximately 64,950 cubic yards. The following elements were elevated at least three times background:

|                      |                        |
|----------------------|------------------------|
| Mercury: 0.964 mg/kg | Manganese: 2,200 mg/kg |
| Lead: 84.5 mg/kg     | Antimony: 9.83 mg/kg   |
| Zinc: 256 mg/kg      |                        |
- The volume of waste rock associated with this site was estimated to be approximately 23,100 cubic yards; however, metals concentrations were not significantly elevated (<3X) above background concentrations.
- No discharging adits, filled shafts, seeps, or springs were identified at the site.
- No surface water was observed on or near the site during the investigation. The nearest surface water, Jennies Fork, was located approximately 0.5 miles from the site; consequently, no surface water or sediment samples were collected.
- Four potentially hazardous partially collapsed shafts were identified at the site.



**Bald Mountain PA# 25-061**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/19/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 25-061-TP-1 | 14.3          | 50.4          | 0.9 UJ        | 3.62 J        | 5.94 J        | 79.1          | 9450          | 0.523         | 2200          | 4.55 J        | 142           | 6.37 U        | 256           | NR                 |
| 25-061-TP-2 | 16.5          | 117           | 1.0 UJ        | 3.68 J        | 3.73 J        | 56.4          | 9870          | 0.964         | 1810          | 4.72 J        | 84.5          | 9.83          | 158           | NR                 |
| 25-061-WR-1 | 48.8          | 64.7          | 0.7 UJ        | 6.81 J        | 5.51 J        | 36.6          | 14200         | 0.324         | 994           | 7.37 J        | 41.7          | 4.7 U         | 125           | NR                 |
| BACKGROUND  | 25 J          | 650           | 0.4 UJ        | 5.6           | 10.7          | 32.6          | 14700         | 0.187         | 662           | 14 J          | 28            | 3 UJ          | 75            | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID       | TOTAL SULFUR<br>% | TOTAL SULFUR ACID BASE<br>t/1000t | NEUTRAL POTENT.<br>t/1000t | SULFUR ACID BASE POTENT.<br>t/1000t | SULFATE SULFUR<br>% | PYRITIC SULFUR<br>% | ORGANIC SULFUR<br>% | PYRITIC SULFUR ACID BASE<br>t/1000t | SULFUR ACID BASE POTENT.<br>t/1000t |
|----------------|-------------------|-----------------------------------|----------------------------|-------------------------------------|---------------------|---------------------|---------------------|-------------------------------------|-------------------------------------|
| 25-061-TP-1    | 0.07              | 2.19                              | 38.7                       | 36.6                                | 0.03                | 0.01                | 0.03                | 0.31                                | 38.4                                |
| 25-061-TP-2    | 0.01              | 0.31                              | 60.1                       | 59.8                                | <0.01               | 0.01                | 0.01                | 0.31                                | 59.8                                |
| 25-061-TP-2DUP | <0.01             | 0                                 | 60.3                       | 60.3                                | <0.01               | 0.01                | 0.01                | 0.31                                | 60                                  |
| 25-061-WR-1    | 0.02              | 0.62                              | 57.9                       | 57.2                                | <0.01               | <0.01               | 0.03                | 0                                   | 57.9                                |

**LEGEND**

TP1 - Composite of subsamples TP1A, 1B, 2A-A, 2A-B, 2A-C, and 2B-A.  
TP2 - Composite of subsamples TP2B-B and 2B-C.  
WR1 - Composite of subsamples WR1A, 1B, 2A, and 2B.  
BACKGROUND - From the Big Ox Mine (25-116-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |  |
|--|--|
| Mine/Site Name: <u>Big Ox Millsite</u>   | County: <u>Lewis and Clark</u>                     |
| Legal Description: <u>T 12N R 6W</u>   | Section(s): <u>NW 1/4, SW 1/4, Sec. 24</u>         |
| Mining District: <u>Marysville</u>   | Mine Type: <u>Millsite/Au, Ag, Cu, Pb</u>          |
| Latitude: <u>N 46° 47' 33"</u>   | Primary Drainage: <u>Little Prickly Pear Creek</u> |
| Longitude: <u>W 112° 18' 12"</u>   | USGS Code: <u>10030101</u>                         |
| Land Status: <u>Private</u>  | Secondary Drainage: <u>Deer Creek</u>              |
| Quad: <u>Canyon Creek</u>  | Date Investigated: <u>June 9, 1993</u>             |
| Inspectors: <u>Bullock, Lasher/Pierson</u>   | P.A. # <u>25-115</u>                               |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |  |

- There were approximately 1,500 cubic yards of tailings on site. The following elements were elevated at least three times background:

|                        |                     |
|------------------------|---------------------|
| Arsenic: 285J mg/kg    | Cadmium: 221 mg/kg  |
| Copper: 1,130 mg/kg    | Mercury: 6.07 mg/kg |
| Manganese: 2,500 mg/kg | Lead: 10,900 mg/kg  |
| Antimony: 107J mg/kg   | Zinc: 24,000 mg/kg  |
- There was no waste rock on site. The mine was the Big Ox Mine P.A. #25-116.
- There were no discharging mine openings on site.
- Deer Creek was flowing through the tailings at the time of this investigation. There was an observed release of lead in downstream surface water. No MCL/MCLGs were exceeded. The chronic aquatic life criteria for lead was exceeded in downstream surface water. Stream sediment samples also documented releases of arsenic, cadmium, copper, mercury, manganese, lead, antimony, and zinc.
- There were no hazardous openings on site. There were numerous collapsing buildings including the mill that were classified as hazardous, but may be of some historical significance.

**Big Ox Millsite PA# 25-115**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/09/93**

| SOLID MATRIX ANALYSES   |                   |                                      |                               |   |                        |                        |                        |   |   |               |               |               |               |                    |
|---|-------------------|--------------------------------------|-------------------------------|---|------------------------|------------------------|------------------------|---|---|---------------|---------------|---------------|---------------|--------------------|
| Metals in soils<br>Results per dry weight basis   |                   |                                      |                               |   |                        |                        |                        |   |   |               |               |               |               |                    |
| FIELD ID  | As<br>(mg/Kg)     | Ba<br>(mg/Kg)                        | Cd<br>(mg/Kg)                 | Co<br>(mg/Kg)                             | Cr<br>(mg/Kg)          | Cu<br>(mg/Kg)          | Fe<br>(mg/Kg)          | Hg<br>(mg/Kg)                             | Mn<br>(mg/Kg)                             | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
| 25-115-SE-1   | 138 J             | 42.1                                 | 84                            | 4.8                                       | 4.8                    | 426                    | 21400                  | 8.84                                      | 3280                                      | 20 J          | 6790          | 54 J          | 8810          | NR                 |
| 25-115-SE-2   | 22 J              | 86.7                                 | 0.5 UJ                        | 3.2                                       | 10.1                   | 10.8                   | 10300                  | 0.095                                     | 209                                       | 9 J           | 18            | 4 UJ          | 62            | NR                 |
| 25-115-TP-1   | 285 J             | 25.8                                 | 221                           | 5.6                                       | 3.3                    | 1130                   | 27500                  | 6.07                                      | 2500                                      | 19 J          | 10900         | 107 J         | 24000         | NR                 |
| BACKGROUND  | 25 J              | 650                                  | 0.4 UJ                        | 5.6                                       | 10.7                   | 32.6                   | 14700                  | 0.187                                     | 662                                       | 14 J          | 28            | 3 UJ          | 75            | NR                 |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                   |                                      |                               |   |                        |                        |                        |   |   |               |               |               |               |                    |
| Acid/Base Accounting  |                   |                                      |                               |   |                        |                        |                        |   |   |               |               |               |               |                    |
| FIELD ID  | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |               |               |               |               |                    |
| 25-115-TP-1   | 4.26              | 133                                  | 146                           | 13.9                                      | 0.29                   | 1.62                   | 2.35                   | 50.6                                      | 95.5                                      |               |               |               |               |                    |

| WATER MATRIX ANALYSES   |                           |          |         |           |         |      |      |      |      |        |      |        |                                      |     |
|---|---------------------------|----------|---------|-----------|---------|------|------|------|------|--------|------|--------|--------------------------------------|-----|
| Metals in Water<br>Results in ug/L  |                           |          |         |           |         |      |      |      |      |        |      |        |                                      |     |
| FIELD ID  | As                        | Ba       | Cd      | Co        | Cr      | Cu   | Fe   | Hg   | Mn   | Ni     | Pb   | Sb     | HARDNESS<br>CALC.<br>Zn (mg CaCO3/L) |     |
| 25-115-SW-1   | 10.5                      | 52.7     | 2.55 U  | 5.99 U    | 7.7     | 4.27 | 22.8 | 0.19 | 3.6  | 12.1   | 28.9 | 18.3 U | 32.1                                 | 212 |
| 25-115-SW-2   | 10.1                      | 73.1     | 2.87    | 5.99 U    | 5 U     | 2.43 | 986  | 0.18 | 21.8 | 8.78 U | 3.82 | 18.3 U | 18.8                                 | 242 |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                           |          |         |           |         |      |      |      |      |        |      |        |                                      |     |
| Wet Chemistry<br>Results in mg/l  |                           |          |         |           |         |      |      |      |      |        |      |        |                                      |     |
| FIELD ID  | TOTAL DISSOLVED<br>SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |      |      |      |      |        |      |        |                                      |     |
| 25-115-SW-1   | 223                       | < 5.0    | 25      | < 0.05    | NR      |      |      |      |      |        |      |        |                                      |     |
| 25-115-SW-2   | 283                       | < 5.0    | 24      | 0.19      | NR      |      |      |      |      |        |      |        |                                      |     |

**LEGEND**

SE1 - Deer Creek below tailings @ the dam breach.  
 SE2 - Upgradient sample @ the old well casing.  
 TP1 - Composite of subsamples TP1-1A, 1-1B, and 1-2A.  
 BACKGROUND - From the Big Ox Mine (25-116-SS-1).

SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Big Ox Mine</u>                    | County: <u>Lewis and Clark</u>                     |
| Legal Description: T <u>12N</u> R <u>6W</u>           | Section(s): <u>NE 1/4, SE 1/4, Sec. 13</u>         |
| Mining District: <u>Marysville</u>                    | Mine Type: <u>Hardrock/Au, Ag, Pb, Cu</u>          |
| Latitude: <u>N 46° 47' 28"</u>                        | Primary Drainage: <u>Little Prickly Pear Creek</u> |
| Longitude: <u>W 112° 17' 45"</u>                      | USGS Code: <u>10030101</u>                         |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Deer Creek</u>              |
| Quad: <u>Canyon Creek</u>                             | Date Investigated: <u>June 9, 1993</u>             |
| Inspectors: <u>Babits, Flammang</u>                   | P.A. # <u>25-116</u>                               |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- Ore derived from this mine was milled at the Big Ox Mill (P.A.# 25-115), which was investigated in conjunction with this site.
- The volume of waste rock associated with this site was estimated to be approximately 3,000 cubic yards. The following elements were elevated at least three times background:

|                            |                            |
|----------------------------|----------------------------|
| Arsenic: 77J mg/kg         | Cadmium: 9.6 to 11.3 mg/kg |
| Copper: 111 to 260 mg/kg   | Mercury: 1.08 mg/kg        |
| Lead: 596 to 1,680 mg/kg   | Antimony: 9J to 16J mg/kg  |
| Zinc: 1,200 to 1,550 mg/kg |                            |
- No discharging adits, filled shafts, seeps, or springs were identified at the site during the investigation.
- No surface water was observed on or near the site. The nearest surface water was located approximately 1,500 feet away; consequently, no surface water or sediment samples were collected.
- One potentially hazardous partially open adit was identified at the site.



**Big Ox Mine PA# 25-116**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 06/09/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 25-116-WR-1 | 53 J          | 167           | 9.6           | 16.6          | 11            | 260           | 25200         | 0.247         | 700           | 10 J          | 596           | 16 J          | 1200          | NR                 |
| 25-116-WR-2 | 25 J          | 232           | 0.4 UJ        | 6.8           | 12.3          | 19.7          | 14400         | 0.147         | 591           | 13 J          | 24            | 3 UJ          | 49            | NR                 |
| 25-116-WR-4 | 77 J          | 138           | 11.3          | 5.4           | 11.9          | 111           | 18400         | 1.08          | 827           | 12 J          | 1680          | 9 J           | 1550          | NR                 |
| BACKGROUND  | 25 J          | 650           | 0.4 UJ        | 5.6           | 10.7          | 32.6          | 14700         | 0.187         | 662           | 14 J          | 28            | 3 UJ          | 75            | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE<br>t/1000t | NEUTRAL POTENT.<br>t/1000t | SULFUR ACID BASES<br>t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE<br>t/1000t | SULFUR ACID BASE<br>t/1000t |
|-------------|----------------|-----------------------------------|----------------------------|------------------------------|------------------|------------------|------------------|-------------------------------------|-----------------------------|
| 25-116-WR-1 | 0.89           | 27.8                              | 203                        | 175                          | <0.01            | 0.96             | 0.03             | 30                                  | 173                         |

**LEGEND**

WR1 - Composite of subsamples WR1A and 1B.  
WR2 - Sample of the WR2 subsample.  
WR4 - Composite of subsamples WR4A, 4B, 7A, and 7B.  
BACKGROUND - SE of mill building on top of hill before mines.  
From the Big Ox Mine (25-116-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Belmont  
Legal Description: T 12N R 6W  
Mining District: Marysville  
Latitude: N 46° 44' 45"  
Longitude: W 112° 19' 05"  
Land Status: Private  
Quad: Greenhorn Mountain  
Inspectors: Babits, Flammang, Lasher  
Organization: Pioneer Technical Services, Inc.

County: Lewis and Clark  
Section(s): SE 1/4, SW 1/4, Sec. 35  
Mine Type: Hardrock/Au  
Primary Drainage: Silver Creek  
USGS Code: 10030101  
Secondary Drainage: Rawhide Gulch  
Date Investigated: August 19, 1993  
P.A. # 25-167

- The volume of tailings associated with this site was estimated to be approximately 57,030 cubic yards. The following elements were elevated at least three times background:  
Mercury: 0.464 to 1.93 mg/kg
- The volume of waste rock associated with this site was estimated to be approximately 18,800 cubic yards. The following elements were elevated at least three times background:  
Mercury: 0.723J mg/kg
- No discharging adits, filled shafts, seeps, or springs were identified at the site.
- No surface water was observed on or near the site. The nearest surface water was located over 1,000 feet from the site; consequently, no surface water or sediment samples were collected.
- Potential safety hazards associated with this site included three open stopes, a collapsing mill building, and several oversteepened and unstable slopes.

**Belmont PA# 25-167**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/19/93**

| SOLID MATRIX ANALYSES   |                      |   |                               |   |                        |                        |                        |   |   |  |               |               |               |                    |
|---|----------------------|---|-------------------------------|---|------------------------|------------------------|------------------------|---|---|--|---------------|---------------|---------------|--------------------|
| Metals in soils<br>Results per dry weight basis   |                      |   |                               |   |                        |                        |                        |   |   |  |               |               |               |                    |
| FIELD ID  | As<br>(mg/Kg)        | Ba<br>(mg/Kg)                           | Cd<br>(mg/Kg)                 | Co<br>(mg/Kg)                             | Cr<br>(mg/Kg)          | Cu<br>(mg/Kg)          | Fe<br>(mg/Kg)          | Hg<br>(mg/Kg)                             | Mn<br>(mg/Kg)                             | Ni<br>(mg/Kg)  | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
| 25-167-TP-1   | 28                   | 30.2                                    | 1.0 UJ                        | 1.61 J                                    | 2.87 J                 | 56.8                   | 6510                   | 1.93                                      | 1190                                      | 2.38 U   | 48.4          | 10            | 230           | NR                 |
| 25-167-TP-2   | 32.2                 | 36.2                                    | 0.7 UJ                        | 1.85 J                                    | 2.61 J                 | 38.1                   | 6840                   | 0.464                                     | 1520                                      | 3.54 J   | 38.1          | 5.74          | 208           | <0.277             |
| 25-167-WR-1   | 19 J                 | 26.5 J                                  | 0.4 U                         | 3.07                                      | 4.46                   | 35.8 J                 | 10700 J                | 0.723 J                                   | 630 J                                     | 5.27   | 14.6 J        | 4.97 U        | 65.6 J        | NR                 |
| BACKGROUND  | 38 J                 | 239                                     | 0.5 UJ                        | 8.2                                       | 14.1                   | 49.7                   | 19500                  | 0.122                                     | 1000                                      | 15 J   | 80            | 4 J           | 153           | NR                 |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                      |   |                               |   |                        |                        |                        |   |   |  |               |               |               |                    |
| Acid/Base Accounting  |                      |   |                               |   |                        |                        |                        |   |   |  |               |               |               |                    |
| FIELD ID  | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | LEGEND   |               |               |               |                    |
| 25-167-TP-1   | <0.01                | 0                                       | 74.3                          | 74.3                                      | <0.01                  | <0.01                  | 0.01                   | 0   | 74.3                                      | TP1 - Composite of subsamples TP1A-A, 1A-B, 1A-C, 1A-D, 1A-E, and 1A-F.<br>TP2 - Composite of subsamples TP2A-A, 2A-B, 2A-C, 2A-D, and 3.<br>WR1 - Composite of subsamples WR1A, 1B, 2, and 3.<br>BACKGROUND - From Empire Millsite (25-175-SS-1). |               |               |               |                    |
| 25-167-TP-2   | <0.01                | 0                                       | 74.4                          | 74.4                                      | <0.01                  | <0.01                  | <0.01                  | 0   | 74.4                                      |  |               |               |               |                    |
| 25-167-WR-1   | <0.01                | 0                                       | 96.8                          | 96.8                                      | <0.01                  | 0.01                   | 0.01                   | 0.31                                      | 96.5                                      |  |               |               |               |                    |
|   |                      |   |                               |   |                        |                        |                        |   |   |  |               |               |               |                    |

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |  |
|--|--|
| Mine/Site Name: <u>Piegan Gloster Millsite</u>     | County: <u>Lewis and Clark</u>                     |
| Legal Description: T <u>12N</u> R <u>6W</u>        | Section(s): <u>Sec. 21 and Sec. 27</u>             |
| Mining District: <u>Marysville</u>                 | Mine Type: <u>Millsite/Unknown</u>                 |
| Latitude: <u>N 46° 46' 12"</u>                     | Primary Drainage: <u>Little Prickly Pear Creek</u> |
| Longitude: <u>W 112° 20' 43"</u>                   | USGS Code: <u>10030101</u>                         |
| Land Status: <u>Private</u>                        | Secondary Drainage: <u>Piegan Creek</u>            |
| Quad: <u>Canyon Creek</u>                          | Date Investigated: <u>September 1, 1993</u>        |
| Inspectors: <u>M. Babits, S. Babits, Flammang,</u> | P.A. # <u>25-172</u>                               |
| <u>Bullock/Pierson</u>                             |  |
| Organization: <u>Pioneer Technical Services,</u>   |  |
| <u>Inc./Thomas, Dean and Hoskins, Inc.</u>         |  |

- The volume of tailings associated with this site was estimated to be approximately 335,820 cubic yards. The following elements were elevated at least three times background:

|                           |                                 |
|---------------------------|---------------------------------|
| Cadmium: 4.3 to 7.7 mg/kg | Copper: 157JX to 272JX mg/kg    |
| Mercury: 1.17JX mg/kg     | Manganese: 3,820 to 5,110 mg/kg |
| Lead: 112 to 1,940 mg/kg  | Zinc: 400J to 2,620J mg/kg      |
- No waste rock was observed at this site during the investigation.
- No discharging adits, filled shafts, seeps, or springs were identified at the site.
- Piegan Creek was flowing directly through the tailings at this site. Surface water and sediment samples were collected upstream and downstream from the site. Observed releases to Piegan Creek were documented for manganese and zinc. The chronic aquatic life criteria for lead was exceeded in the downstream sample, which was directly attributable to the site.
- Observed releases to Piegan Creek (sediment) were also documented for copper and lead.
- No hazardous mine openings were identified at the site; however, the mill building was collapsing and potentially hazardous.



**Piegan Gloster Mill PA# 25-172**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 09/01/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 25-172-SE-1 | 9.34 U     | 43.1 J     | 1.8 U      | 2.82 J     | 8.39 J     | 26 JX      | 9170       | 6 JX       | 225        | 4.26 U     | 102        | 12.4 UJ    | 119 J      | 0.464 U         |
| 25-172-SE-2 | 33.1 J     | 148 J      | 2.5        | 3.47 J     | 7.34 J     | 83 JX      | 10700      | 1.62 JX    | 2670       | 8.61 J     | 698        | 6.44 UJ    | 865 J      | 0.339           |
| 25-172-TP-1 | 49 J       | 59.3 J     | 0.9 U      | 3 J        | 3.24 J     | 45.7 JX    | 11100      | 1.17 JX    | 537        | 2.14 U     | 112        | 6.21 UJ    | 400 J      | 0.919           |
| 25-172-TP-2 | 47.5 J     | 179 J      | 4.3        | 3.39 J     | 8.52 J     | 157 JX     | 11900      | 0.165 JX   | 3820       | 7.71 J     | 1290       | 6.38 UJ    | 1620 J     | 9.96            |
| 25-172-TP-3 | 66.5 J     | 271 J      | 7.7        | 4.76 J     | 11.3 J     | 272 JX     | 14000      | 0.274 JX   | 5110       | 10.1 J     | 1940       | 6.89 J     | 2620 J     | 7.92            |
| BACKGROUND  | 33.3 J     | 150 J      | 0.9 U      | 6.26 J     | 14.3 J     | 35.8 JX    | 14700      | 0.367 JX   | 729        | 10.6 J     | 34.4       | 6.4 UJ     | 83.1 J     | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 25-172-TP-1 | <0.01          | 0                              | 28.6                    | 28.6                             | <0.01            | <0.01            | 0.01             | 0                                | 28.6                             |
| 25-172-TP-2 | 0.04           | 1.25                           | 77.3                    | 76                               | <0.01            | 0.02             | 0.03             | 0.62                             | 76.7                             |
| 25-172-TP-3 | 0.07           | 2.19                           | 102                     | 99.6                             | 0.02             | 0.01             | 0.04             | 0.31                             | 102                              |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu     | Fe     | Hg     | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. (mg CaCO3/L) |
|-------------|--------|------|--------|-------|--------|--------|--------|--------|------|--------|--------|--------|-----------------|-----------------------------|
| 25-172-SW-1 | 5.42 J | 36.9 | 2.57 U | 9.7 U | 6.83 U | 9.87 J | 243 JX | 0.12 U | 10.8 | 12.7 U | 5.06 J | 30.7 U | 7.57 U          | 184                         |
| 25-172-SW-2 | 6.58 J | 53.2 | 2.57 U | 9.7 U | 9.57 J | 4.6 J  | 118 JX | 0.12 U | 50.2 | 12.7 U | 13.6 J | 30.7 U | 29.3            | 219                         |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 25-172-SW-1 | 202                    | < 5      | 18      | 0.11      | < 0.005 |
| 25-172-SW-2 | 218                    | < 5      | 20      | < 0.05    | < 0.005 |

**LEGEND**

SE1 - Upgradient in Piegan Creek below confluence of 2 tributaries.  
SE2 - Downgradient in Piegan Creek below tailings pond 3, before placer.  
TP1 - Composite of subsamples TP1A-A, 1A-B, and 1B-A.  
TP2 - Composite of subsamples TP2A-A through 2A-D, 2B-A through 2B-C, and 4A through 4C.  
TP3 - Composite of subsamples TP3A-A, 3A-B, 3A-C, 3A-D, 3B-A, 3B-B, and 3B-C.  
BACKGROUND - From the Piegan Gloster Mill (25-172-SS-1).  
SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Empire Millsite  
Legal Description: T 12N R 6W  
Mining District: Marysville  
Latitude: N 46° 45' 25"  
Longitude: W 112° 21' 45"  
Land Status: Private  
Quad: Canyon Creek and Granite Butte  
Inspectors: Bullock, Babits, Flammang, Clark,  
Lasher/Pierson  
Organization: Pioneer Technical Services, Inc.  
/Thomas, Dean and Hoskins, Inc.

County: Lewis and Clark  
Section(s): Sec. 32 and 33  
Mine Type: Millsite/Au, Ag, Pb, Zn  
Primary Drainage: Little Prickly Pear Creek  
USGS Code: 10030101  
Secondary Drainage: Empire Creek  
Date Investigated: June 9, 1993  
P.A. # 25-175

- The volume of mill tailings associated with this site was estimated to be approximately 16,000 cubic yards. The following elements were elevated at least three times background:

|                               |                            |
|-------------------------------|----------------------------|
| Cadmium: 13.4 to 83.7 mg/kg   | Copper: 1840 to 6660 mg/kg |
| Mercury: 0.505 to 0.893 mg/kg | Lead: 7310 to 13,700 mg/kg |
| Antimony: 15J to 54J mg/kg    | Zinc: 5020 to 39,300 mg/kg |
- There was no waste rock associated with this site.
- There were no discharging adits or shafts, or seeps or springs associated with this site.
- Empire Creek flowed through the mill tailing for approximately 4000 feet adjacent to and below the mill. Observed releases were documented for copper, lead, and zinc. There were no MCL/MCLGs exceeded during this sampling event. The chronic aquatic life criteria for lead was exceeded and directly attributable to this site. Cyanide was also slightly elevated in the downgradient sample, but did not constitute an observed release.
- The mill building was a hazardous structure, although may be historically significant.
- Other possible hazardous materials on site included a partially full 55-gallon barrel of black petroleum sludge and several barrels of unknown white powdery material; all located inside the mill building.

**Empire Mill PA# 25-175**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/09/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 25-175-SE-1 | 32 J       | 169        | 1.3 UJ     | 3.8        | 13.8       | 123        | 13400      | 0.443      | 192        | 5 J        | 425        | 9 UJ       | 501        | 1.88            |
| 25-175-SE-2 | 66 J       | 77.9       | 41.8       | 5.2        | 15.7       | 3350       | 18900      | 0.649      | 1690       | 15 J       | 7270       | 38 J       | 20000      | 0.87            |
| 25-175-TP-1 | 88 J       | 98.7       | 83.7       | 8.2        | 42.6       | 6660       | 26300      | 0.893      | 2380       | 27 J       | 13700      | 54 J       | 39300      | 0.18            |
| 25-175-TP-2 | 30 J       | 28.8       | 13.4       | 1.2        | 7.5        | 1840       | 9700       | 0.505      | 1660       | 11 J       | 7310       | 15 J       | 5020       | 0.87            |
| 25-175-TP-3 | 47 J       | 64.9       | 38.2       | 5.1        | 24.1       | 4160       | 18800      | 0.769      | 2340       | 17 J       | 10600      | 28 J       | 15600      | 0.99            |
| BACKGROUND  | 38 J       | 239        | 0.5 UJ     | 8.2        | 14.1       | 49.7       | 19500      | 0.122      | 1000       | 15 J       | 80         | 4 J        | 153        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 25-175-TP-1 | 0.02           | 0.62                           | 108                     | 108                              | <0.01            | <0.01            | 0.02             | 0                                | 108                              |
| 25-175-TP-2 | <0.01          | 0                              | 110                     | 110                              | <0.01            | <0.01            | 0.02             | 0                                | 110                              |
| 25-175-TP-3 | 0.05           | 1.56                           | 141                     | 139                              | <0.01            | 0.03             | 0.02             | 0.94                             | 140                              |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co     | Cr  | Cu     | Fe   | Hg   | Mn    | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|------|--------|--------|-----|--------|------|------|-------|--------|------|--------|-----------------|----------------|
| 25-175-SW-1 | 5.62 | 46.4 | 3.2    | 5.99 U | 5 U | 1.35 U | 20.6 | 0.14 | 2.6 U | 8.78 U | 2.2  | 18.3 U | 6 U             | 173            |
| 25-175-SW-2 | 3.59 | 94.1 | 2.55 U | 5.99 U | 5 U | 13.4   | 22.8 | 0.14 | 6.27  | 8.78 U | 13.6 | 18.3 U | 85.5            | 179            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 25-175-SW-1 | 195                    | < 5.0    | 20      | 0.27      | 0.01    |
| 25-175-SW-2 | 201                    | < 5.0    | 18      | < 0.05    | 0.02    |

**LEGEND**

SE1 - Upgradient Empire Creek, 25' upstream from where creek crosses the road.  
SE2 - At the culvert below new dam.  
TP1 - Composite of subsamples TP2A and 3-2A.  
TP2 - Composite of subsamples TP3-1C, 3-2B, and 3-2C.  
TP3 - Composite of subsamples TP3-1D and 3-2D.  
BACKGROUND - Same as Empire Mill (25-175-SS-1).

SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Bald Butte Millsite  
Legal Description: T 11N R 6W  
Mining District: Marysville  
Latitude: N 46° 42' 13"  
Longitude: W 112° 21' 24"  
Land Status: Private/Public  
Quad: Greenhorn Mountain  
Inspectors: Babits, Flammang, Lasher  
Organization: Pioneer Technical Services, Inc.

County: Lewis and Clark  
Section(s): NW 1/4, NE 1/4, Sec. 16  
Mine Type: Millsite/Unknown  
Primary Drainage: Dog Creek  
USGS Code: 17010201  
Secondary Drainage: Dago Creek  
Date Investigated: August 18, 1993  
P.A. # 25-179

- The volume of tailingw associated with this site was estimated to be approximately 48,700 cubic yards. The following elements were elevated at least three times background:

|                             |                                |
|-----------------------------|--------------------------------|
| Arsenic: 191J to 202J mg/kg | Cadmium: 14.9 to 18.8 mg/kg    |
| Copper: 538J to 852J mg/kg  | Mercury: 0.596J to 17.5J mg/kg |
| Lead: 612J to 2,500J mg/kg  | Zinc: 1,940J to 2,750 mg/kg    |
- The volume of waste rock associated with this site was estimate to be approximately 850 cubic yards. The following elements were elevated at least three times background:

|                        |                      |
|------------------------|----------------------|
| Arsenic: 11,800J mg/kg | Cadmium: 410 mg/kg   |
| Copper: 1,630J mg/kg   | Iron: 80,900J mg/kg  |
| Lead: 19,800J mg/kg    | Antimony: 72.7 mg/kg |
| Zinc: 73,500J mg/kg    |                      |
- No discharging adits, filled shafts, seeps, or springs were identified at the site during the investigation.
- Dog Creek was flowing directly through the site; surface water and sediment samples were collected upstream and downstream from the site. An observed release to Dog Creek was documented for iron. The chronic aquatic life criteria for lead was exceeded in the downstream sample, which was directly attributable to the site.
- No hazardous mine openings were identified at the site; however, the mill building was collapsing and potentially hazardous.



**Bald Butte Millsite PA# 25-179**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/18/93**

| SOLID MATRIX ANALYSES   |                      |   |                                |   |                        |                        |                        |   |   |               |               |               |               |                    |
|---|----------------------|---|--------------------------------|---|------------------------|------------------------|------------------------|---|---|---------------|---------------|---------------|---------------|--------------------|
| Metals in soils<br>Results per dry weight basis   |                      |   |                                |   |                        |                        |                        |   |   |               |               |               |               |                    |
| FIELD ID  | As<br>(mg/Kg)        | Ba<br>(mg/Kg)                           | Cd<br>(mg/Kg)                  | Co<br>(mg/Kg)                             | Cr<br>(mg/Kg)          | Cu<br>(mg/Kg)          | Fe<br>(mg/Kg)          | Hg<br>(mg/Kg)                             | Mn<br>(mg/Kg)                             | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
| 25-179-SE-1   | 209 J                | 281 J                                   | 34.6                           | 10.4                                      | 15.8                   | 928 J                  | 24400 J                | 6.26 J                                    | 8950 J                                    | 15.1          | 3390 J        | 34.7          | 4240 J        | NR                 |
| 25-179-SE-2   | 407 J                | 209 J                                   | 14.7                           | 7.39                                      | 10.5                   | 431 J                  | 23100 J                | 1.39 J                                    | 7760 J                                    | 7.94          | 1570 J        | 13.3          | 2100 J        | NR                 |
| 25-179-TP-1   | 216 J                | 88.7 J                                  | 15.5                           | 3.37                                      | 10.4                   | 538 J                  | 15500 J                | 17.5 J                                    | 731 J                                     | 9.64          | 1370 J        | 7.16 U        | 2470 J        | NR                 |
| 25-179-TP-2   | 191 J                | 63.4 J                                  | 14.9                           | 2.45                                      | 8.34                   | 591 J                  | 11200 J                | 14.4 J                                    | 409 J                                     | 7.6           | 1110 J        | 6.66 U        | 1940 J        | NR                 |
| 25-179-TP-3   | 193 J                | 117 J                                   | 18.8                           | 6.94                                      | 13.3                   | 684 J                  | 18000 J                | 0.596 J                                   | 1050 J                                    | 11.9          | 612 J         | 6.61 U        | 2280 J        | NR                 |
| 25-179-TP-4   | 202 J                | 97.7 J                                  | 14.9                           | 5.51                                      | 19.4                   | 852 J                  | 16300 J                | 15 J                                      | 1130 J                                    | 10.5          | 2500 J        | 12.3          | 2750 J        | NR                 |
| 25-179-WR-1   | 11800 J              | 21.7 J                                  | 410.0                          | 7.58                                      | 10.9                   | 1630 J                 | 80900 J                | 0.282 J                                   | 1670 J                                    | 10.5          | 19800 J       | 72.7          | 73500 J       | NR                 |
| BACKGROUND  | 51.1 J               | 290 J                                   | 1.9                            | 5.21                                      | 8.25                   | 82.4 J                 | 7590 J                 | 0.109 J                                   | 2390 J                                    | 4.81          | 139 J         | 10.2 U        | 190 J         | NR                 |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                      |   |                                |   |                        |                        |                        |   |   |               |               |               |               |                    |
| Acid/Base Accounting  |                      |   |                                |   |                        |                        |                        |   |   |               |               |               |               |                    |
| FIELD ID  | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL.<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |               |               |               |               |                    |
| 25-179-TP-1   | 0.04                 | 1.25                                    | 17.3                           | 16.1                                      | <0.01                  | <0.01                  | 0.05                   | 0   | 17.3                                      |               |               |               |               |                    |
| 25-179-TP-2   | 0.27                 | 8.43                                    | 15                             | 6.6                                       | 0.11                   | 0.05                   | 0.11                   | 1.56                                      | 13.5                                      |               |               |               |               |                    |
| 25-179-TP-3   | 0.07                 | 2.19                                    | 8.43                           | 6.24                                      | 0.03                   | 0.01                   | 0.03                   | 0.31                                      | 8.12                                      |               |               |               |               |                    |
| 25-179-TP-4   | 0.1                  | 3.12                                    | 12.6                           | 9.45                                      | 0.04                   | 0.01                   | 0.05                   | 0.31                                      | 12.3                                      |               |               |               |               |                    |
| 25-179-WR-1   | 7.12                 | .222                                    | 183                            | -39                                       | <0.01                  | 4.23                   | 6.84                   | 132                                       | 51.2                                      |               |               |               |               |                    |

| WATER MATRIX ANALYSES   |                              |          |         |           |         |        |      |        |      |        |        |        |       |                                      |
|---|------------------------------|----------|---------|-----------|---------|--------|------|--------|------|--------|--------|--------|-------|--------------------------------------|
| Metals in Water<br>Results in ug/L  |                              |          |         |           |         |        |      |        |      |        |        |        |       |                                      |
| FIELD ID  | As                           | Ba       | Cd      | Co        | Cr      | Cu     | Fe   | Hg     | Mn   | Ni     | Pb     | Sb     | Zn    | HARDNESS<br>CALC.<br>Zn (mg CaCO3/L) |
| 25-179-SW-1   | 9.14                         | 38       | 2.57 U  | 9.7 U     | 6.83 U  | 4.43 J | 90.7 | 0.12 U | 31.2 | 12.7 U | 4.31 J | 30.7 U | 118 J | 154                                  |
| 25-179-SW-2   | 24.3                         | 34       | 2.57 U  | 9.7 U     | 6.83 U  | 6 J    | 283  | 0.12 U | 102  | 12.7 U | 7.08 J | 30.7 U | 71 J  | 134                                  |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                              |          |         |           |         |        |      |        |      |        |        |        |       |                                      |
| Wet Chemistry<br>Results in mg/l  |                              |          |         |           |         |        |      |        |      |        |        |        |       |                                      |
| FIELD ID  | TOTAL<br>DISSOLVED<br>SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |        |      |        |      |        |        |        |       |                                      |
| 25-179-SW-1   | 188                          | < 5.0    | 26      | < 0.05    | NR      |        |      |        |      |        |        |        |       |                                      |
| 25-179-SW-2   | 172                          | < 5.0    | 21      | < 0.05    | NR      |        |      |        |      |        |        |        |       |                                      |

**LEGEND**

SE1 - Upgradient on Dog Creek, 50 feet from mill building.  
 SE2 - Downgradient on Dog Creek, 825 feet from breach.  
 TP1 - Composite of subsamples TP1A-A, 1B-A, and 2A-B.  
 TP2 - Composite of subsamples TP1B-B, 1B-C, 1D-C, and 1D-D.  
 TP3 - Composite of subsamples TP1B-D, and 2B-B.  
 TP4 - Composite of subsamples TP2A-A and 2B-A.  
 WR1 - Sample of the WR1 subsample.  
 BACKGROUND - From the Wild Cat Mine (25-317-SS-1).

SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Argo Millsite  
Legal Description: T 12N R 5W  
Mining District: Marysville  
Latitude: N 46° 45' 02"  
Longitude: W 112° 14' 34"  
Land Status: Private  
Quad: Austin and Silver City  
Inspectors: Bullock, S. Babits  
Organization: Pioneer Technical Services, Inc.

County: Lewis and Clark  
Section(s): SE 1/4, SW 1/4, Sec. 33  
Mine Type: mill/Unknown  
Primary Drainage: Silver Creek  
USGS Code: 10030101  
Secondary Drainage: Silver Creek  
Date Investigated: September 2, 1993  
P.A. # 25-314

- Tailings associated with the Argo Mill were evaluated as part of a larger volume of material associated with the Goldsil Mill (25-365) and were also discussed under that investigation. The volume of mill tailings north of the collapsed Argo mill building were estimated at 65,400 cubic yards. Mercury at 5.42JX mg/kg was elevated at least three times background.
- No discharging adits, springs or seeps were found at the site.
- The tailings were not contained, and approximately 60% unvegetated.
- No waste rock was associated with this site.
- No observed releases to surface water were documented for the site; however, the concentration of mercury was elevated (<3X background soil) in the downstream sediment sample. No exceedances of drinking water standards nor of aquatic life criteria were documented at this site.
- The structures associated with this site were classified as hazardous.

**Argo Millsite PA# 25-314**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 09/02/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 25-365-TP-3 | 13 J       | 58.6 J     | 1 U        | 3.48 J     | 6.54 J     | 53.1 JX    | 8480       | 5.42 JX    | 852        | 3.82 J     | 68.5       | 7.08 UJ    | 137 J      | 0.379 U         |
| 25-365-SE-2 | 34.2 J     | 94 J       | 1 U        | 1.39 J     | 3.85 J     | 23.2 JX    | 6400       | 3.11 JX    | 480        | 3.14 J     | 12.2       | 7.06 UJ    | 64.1 J     | NR              |
| BACKGROUND  | 25 J       | 650        | 0.4 UJ     | 5.6        | 10.7       | 32.6       | 14700      | 0.187      | 662        | 14 J       | 28         | 3 UJ       | 75         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 25-365-TP-3 | <0.01          | 0                              | 49.9                    | 49.9                             | <0.01            | <0.01            | <0.01            | 0                                | 49.9                             |

**LEGEND**

TP3 - Sample of TP1C-A subsample (Goldsil Millsite).  
SE2 - At culvert on 1st road with gate coming from Marysville, below some Goldsil and Argo tailings.  
BACKGROUND - From the Big Ox Mine (25-116-SS-1).  
SW2 - Same as SE2.  
SW3 - 200' upgradient of Argo mill site in Silver Creek.

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co  | Cr     | Cu     | Fe   | Hg     | Mn   | Ni     | Pb   | Sb     | HARDNESS CALC. Zn(mg CaCO3/L) |
|-------------|------|------|--------|-----|--------|--------|------|--------|------|--------|------|--------|-------------------------------|
| 25-365-SW-2 | 4.35 | 73.6 | 4.59 U | 5 U | 6.24 U | 2.33 U | 90.8 | 0.12 U | 15.3 | 10.9 U | 1.69 | 31.7 U | 12.3 195                      |
| 25-365-SW-3 | 2.56 | 68.4 | 4.59 U | 5 U | 6.24 U | 2.33 U | 93.3 | 0.12 U | 16.9 | 10.9 U | 1.53 | 31.7 U | 12.4 181                      |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID.   | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE      |
|-------------|------------------------|----------|---------|-----------|--------------|
| 25-365-SW-2 | 212                    | <        | 5       | 18        | 0.06 < 0.005 |
| 25-365-SW-3 | 189                    | <        | 5       | 18        | 0.09 < 0.005 |

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Wild Cat</u>                       | County: <u>Lewis and Clark</u>                     |
| Legal Description: T <u>11N</u> R <u>6W</u>           | Section(s): <u>SW 1/4, SW 1/4, Sec. 4</u>          |
| Mining District: <u>Marysville</u>                    | Mine Type: <u>Millsite/Unknown</u>                 |
| Latitude: <u>N 46° 43' 49"</u>                        | Primary Drainage: <u>Little Prickly Pear Creek</u> |
| Longitude: <u>W 112° 22' 00"</u>                      | USGS Code: <u>10030101</u>                         |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Lost Horse Creek</u>        |
| Quad: <u>Greenhorn Mountain</u>                       | Date Investigated: <u>August 18, 1993</u>          |
| Inspectors: <u>Babits, Flammang, Lasher</u>           | P.A. # <u>25-317</u>                               |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- The volume of tailings associated with this site was estimated to be approximately 2,000 cubic yards. The following elements were elevated at least three times background:

|                              |                                    |
|------------------------------|------------------------------------|
| Arsenic: 455J to 895J mg/kg  | Cadmium: 14 to 21 mg/kg            |
| Copper: 813J to 1,080J mg/kg | Iron: 26,400J mg/kg                |
| Mercury: 2.3J to 12.2J mg/kg | Manganese: 9,120J to 11,500J mg/kg |
| Lead: 2,580J to 3,330J mg/kg | Antimony: 79.7 to 103 mg/kg        |
| Zinc: 3,190J to 5,310J mg/kg |                                    |
- The volume of waste rock associated with this site was estimated to be approximately 185 cubic yards. No samples were collected due to the relatively small volume.
- No discharging adits, filled shafts, seeps, or springs were identified at the site.
- Intermittent Lost Horse Creek (dry at the time of the investigation) was situated in the center of the site. Sediment samples were collected upstream and downstream from the site. Observed releases to Lost Horse Creek (sediment) were documented for arsenic, cadmium, copper, manganese, lead, and zinc.
- No hazardous mine openings were identified at the site.



**Wild Cat PA# 25-317**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/31/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 25-317-SE-1 | 32.8 J        | 77.4 J        | 1.0           | 2.97          | 5.06          | 41.8 J        | 8640 J        | 0.398 J       | 664 J         | 6.59          | 117 J         | 9.28 U        | 191 J         | 0.518 U            |
| 25-317-SE-2 | 171 J         | 97.5 J        | 4.6           | 3.15          | 6.05          | 219 J         | 13300 J       | 0.916 J       | 2960 J        | 6.24          | 867 J         | 9.27          | 997 J         | 0.314 U            |
| 25-317-TP-1 | 455 J         | 92.5 J        | 14            | 4.7           | 7.99          | 813 J         | 16800 J       | 2.3 J         | 9120 J        | 2.89          | 2580 J        | 79.7          | 3190 J        | 0.278 U            |
| 25-317-TP-2 | 895 J         | 148 J         | 21            | 6.18          | 11.5          | 1080 J        | 26400 J       | 12.2 J        | 11500 J       | 3.99          | 3330 J        | 103           | 5310 J        | 0.348 U            |
| BACKGROUND  | 51.1 J        | 290 J         | 1.9           | 5.21          | 8.25          | 82.4 J        | 7590 J        | 0.109 J       | 2390 J        | 4.81          | 139 J         | 10.2 U        | 190 J         | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 25-317-TP-1 | 0.01              | 0.31                                 | 43.8                          | 43.5                                      | 0.01                   | <0.01                  | <0.01                  | 0   | 43.8                                      |
| 25-317-TP-2 | 0.01              | 0.31                                 | 50.1                          | 49.8                                      | 0.01                   | <0.01                  | <0.01                  | 0   | 50.1                                      |

**LEGEND**

SE1 - Upgradient in Lost Horse Creek.  
SE2 - Downgradient in Lost Horse Creek.  
TP1 - Composite of subsamples TP1, 2A-A, 2A-C, and 2B-A.  
TP2 - Composite of subsamples TP2A-B and 2B-B.  
BACKGROUND - West of creek. From Wild Cat Mine  
(25-317-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Goldsil Millsite  
Legal Description: T 12N R 5W  
Mining District: Marysville  
Latitude: N 46° 45' 00"  
Longitude: W 112° 14' 12"  
Land Status: Private  
Quad: Silver City  
Inspectors: Bullock, M. Babits, S. Babits,  
Flammang, Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Lewis and Clark  
Section(s): SE 1/4, SE 1/4, Sec. 33  
Mine Type: Millsite/Au  
Primary Drainage: Canyon Creek  
USGS Code: 10030101  
Secondary Drainage: Silver Creek  
Date Investigated: September 2, 1993  
P.A. # 25-365

- The volume of tailings associated with this site was estimated to be approximately 700,000 cubic yards. The following elements are elevated at least three times background:

|                            |                                |
|----------------------------|--------------------------------|
| Arsenic: 84.5J mg/kg       | Cadmium: 1 to 3 mg/kg          |
| Copper: 160 to 379 mg/kg   | Mercury: 0.69JX to 223J mg/kg  |
| Lead: 205J to 537J mg/kg   | Antimony: 10.8J to 66.9J mg/kg |
| Zinc: 400J to 1010JX mg/kg | Cyanide: 1.97 to 3.13 mg/kg    |
- There was no waste rock material associated with this site.
- Silver Creek paralleled this site for approximately 1 mile. No observed releases to Silver Creek were documented during this investigation. MCL/MCLGs and aquatic life criteria were not exceeded for this data set. Stream sediment data collected in Silver Creek indicated elevated levels of mercury.
- A variety of hazardous wastes were located in the mill structure, including acids, organic solvents, and other reagents.

**Goldsil Millsite PA# 25-365**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 09/02/93**

## SOLID MATRIX ANALYSES

| Metals in soils   |                | Results per dry weight basis |                          |                                  |                  |                  |                  |                        |                                  |            |            |            |            |                 |
|---|----------------|------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|------------------------|----------------------------------|------------|------------|------------|------------|-----------------|
| FIELD ID  | As (mg/Kg)     | Ba (mg/Kg)                   | Cd (mg/Kg)               | Co (mg/Kg)                       | Cr (mg/Kg)       | Cu (mg/Kg)       | Fe (mg/Kg)       | Hg (mg/Kg)             | Mn (mg/Kg)                       | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 25-365-SE-1   | 66.6 J         | 83.3 J                       | 1.0 U                    | 4.26 J                           | 5.27 J           | 31.8 JX          | 11400            | 0.69 JX                | 787                              | 6.22 J     | 16.2       | 7 UJ       | 62.4 J     | NR              |
| 25-365-SE-2   | 34.2 J         | 94 J                         | 1.0 U                    | 1.39 J                           | 3.85 J           | 23.2 JX          | 6400             | 3.11 JX                | 480                              | 3.14 J     | 12.2       | 7.06 UJ    | 64.1 J     | NR              |
| 25-365-TP-1   | 41.2 J         | 51.7 J                       | 2.0                      | 2.35 J                           | 6.07 J           | 197 JX           | 8470             | 81.4 JX                | 884                              | 3.4 J      | 237        | 10.8 J     | 470 J      | 2.57            |
| 25-365-TP-2   | 37.1 J         | 52.5 J                       | 2.0                      | 1.97 J                           | 4.92 J           | 187 JX           | 7620             | 46.4 JX                | 843                              | 3.43 J     | 207        | 11.1 J     | 400 J      | 2.4             |
| 25-365-TP-3   | 13 J           | 58.6 J                       | 1.0 U                    | 3.48 J                           | 6.54 J           | 53.1 JX          | 8480             | 5.42 JX                | 852                              | 3.82 J     | 68.5       | 7.08 UJ    | 137 J      | 0.379 U         |
| 25-365-TP-4   | 34.9 J         | 74.8 J                       | 2.0                      | 4.9                              | 18.6             | 198              | 11700 J          | 21.4 J                 | 827                              | 13 J       | 245 J      | 31.2 J     | 477 J      | 3.13            |
| 25-365-TP-5   | 84.5 J         | 117 J                        | 3.5                      | 5.96                             | 15.3             | 379              | 18600 J          | 223 J                  | 1430                             | 14 J       | 537 J      | 66.9 J     | 1010 J     | 1.97            |
| 25-365-TP-6   | 36.6 J         | 59.9 J                       | 3.4                      | 4.35                             | 7.86             | 160              | 9210 J           | 86 J                   | 857                              | 8.39 J     | 205 J      | 30.3 J     | 412 J      | 2.82            |
| BACKGROUND  | 25 J           | 650                          | 0.4 UJ                   | 5.6                              | 10.7             | 32.6             | 14700            | 0.187                  | 662                              | 14 J       | 28         | 3 UJ       | 75         | NR              |
| Acid/Base Accounting  |                |                              |                          |                                  |                  |                  |                  |                        |                                  |            |            |            |            |                 |
| FIELD ID  | TOTAL SULFUR % | TOTAL SULFUR t/1000t         | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR t/1000t | SULFUR ACID BASE POTENT. t/1000t |            |            |            |            |                 |
| 25-365-TP-1   | 0.03           | 0.94                         | 84.1                     | 83.1                             | 0.01             | <0.01            | 0.02             | 0                      | 84.1                             |            |            |            |            |                 |
| 25-365-TP-2   | <0.01          | 0                            | 68.5                     | 68.5                             | <0.01            | 0.02             | 0.02             | 0.62                   | 67.8                             |            |            |            |            |                 |
| 25-365-TP-3   | <0.01          | 0                            | 49.9                     | 49.9                             | <0.01            | <0.01            | <0.01            | 0                      | 49.9                             |            |            |            |            |                 |
| 25-365-TP-4   | <0.01          | 0                            | 78.5                     | 78.5                             | <0.01            | <0.01            | 0.02             | 0                      | 78.5                             |            |            |            |            |                 |
| 25-365-TP-5   | 0.05           | 1.56                         | 124                      | 122                              | 0.01             | 0.01             | 0.03             | 0.31                   | 123                              |            |            |            |            |                 |
| 25-365-TP-6   | 0.22           | 6.87                         | 82.9                     | 76.1                             | 0.09             | 0.03             | 0.1              | 0.94                   | 82                               |            |            |            |            |                 |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                |                              |                          |                                  |                  |                  |                  |                        |                                  |            |            |            |            |                 |

## WATER MATRIX ANALYSES

| Metals in Water |      | Results in ug/L |        |     |        |        |      |        |      |        |      |        |                 |       | HARDNESS |  |
|-----------------|------|-----------------|--------|-----|--------|--------|------|--------|------|--------|------|--------|-----------------|-------|----------|--|
| FIELD ID        | As   | Ba              | Cd     | Co  | Cr     | Cu     | Fe   | Hg     | Mn   | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | CALC. |          |  |
| 25-365-SW-1     | 5.29 | 82.7            | 4.59 U | 5 U | 6.24 U | 2.33 U | 123  | 0.12 U | 21.8 | 10.9 U | 1.13 | 31.7 U | 8.71 U          | 212   |          |  |
| 25-365-SW-2     | 4.35 | 73.6            | 4.59 U | 5 U | 6.24 U | 2.33 U | 90.8 | 0.12 U | 15.3 | 10.9 U | 1.69 | 31.7 U | 12.3            | 195   |          |  |
| 25-365-SW-3     | 2.56 | 68.4            | 4.59 U | 5 U | 6.24 U | 2.33 U | 93.3 | 0.12 U | 16.9 | 10.9 U | 1.53 | 31.7 U | 12.4            | 181   |          |  |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Wet Chemistry**

**Results in mg/l**

| FIELD I.D.  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |      |   |       |
|-------------|------------------------|----------|---------|-----------|---------|------|---|-------|
| 25-365-SW-1 | 213                    | <        | 5       | 19        | <       | 0.05 | < | 0.005 |
| 25-365-SW-2 | 212                    | <        | 5       | 18        |         | 0.06 | < | 0.005 |
| 25-365-SW-3 | 189                    | <        | 5       | 18        |         | 0.09 | < | 0.005 |
| 25-365-SW-5 | NR                     | NR       | NR      | NR        |         |      | < | 0.005 |

**LEGEND**

SE1 - At toe of berm with flow gate in Silver Creek.  
SE2 - At culvert (downgradient) at road.  
TP1 - Composite of subsamples TP1A-A through 1A-C and 1B-A through 1B-E.  
TP2 - Composite TP1D-A, B, and C.  
TP3 - Sample of the TP1C subsample (Argo Mill Tailings).  
TP4 - Composite of subsamples TP2A-A, B, C, and 2B.  
TP5 - Composite of subsamples TP3A-A and 3A-B.  
TP6 - Composite of subsamples TP4A-A and 4A-B.

BACKGROUND - From the Big Ox Mine (25-116-SS-1).  
SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.  
SW3 - Upgradient (200') from mill building (Argo) in Silver Creek.  
SW5 - Pregnant pond below mill.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Victory/Evening Star</u>           | County: <u>Lewis and Clark</u>             |
| Legal Description: <u>T 11N R 7W</u>                  | Section(s): <u>SW 1/4, NE 1/4, Sec. 17</u> |
| Mining District: <u>Ophir</u>                         | Mine Type: <u>Hardrock/Au, Ag, Cu</u>      |
| Latitude: <u>N 46° 42' 20"</u>                        | Primary Drainage: <u>Carpenter Creek</u>   |
| Longitude: <u>W 112° 30' 27"</u>                      | USGS Code: <u>17010201</u>                 |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Ophir Creek</u>     |
| Quad: <u>Ophir Creek</u>                              | Date Investigated: <u>July 15, 1993</u>    |
| Inspectors: <u>Bullock, Flammang, Clark</u>           | P.A. # <u>25-010</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- The volume of tailings associated with this site was estimated to be approximately 700 cubic yards. The tailings were very shallow and completely revegetated. The following elements were elevated at least three times background:  
Arsenic: 566 mg/kg                      Copper: 5590 mg/kg  
Iron: 95,600 mg/kg                      Mercury: 6.07 mg/kg
- The volume of waste rock associated with this site was estimated to be approximately 8300 cubic yards. The following elements were elevated at least three times background:  
Copper: 1050 mg/kg  
Mercury: 1.08 mg/kg
- There were no discharging adits or shafts associated with this site.
- Ophir Creek flowed intermittently below this site. The stream channel had been heavily placered and the water flow was often subsurface below the placer tailings piles in the vicinity of this site. No observed releases to surface water were documented during this investigation. No MCL/MCLGs were exceeded and no aquatic life criteria were exceeded. The stream sediment samples collected documented observed releases of arsenic, copper, and mercury, attributable to this site.
- There were no significant hazardous structures or mine openings associated with this site.



**Victory/Evening Star PA# 25-010**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/15/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 25-010-SE-1 | 36 J       | 52.9       | 1.9 U      | 7.1 U      | 11.2       | 490 JX     | 15200      | 2.91 J     | 129        | 9 UJX      | 31 J       | 22 UJ      | 57 J       | NR              |
| 25-010-SE-2 | 6 U        | 72.9       | 0.7 U      | 7          | 13.2       | 28         | 10300      | 0.137      | 186        | 17         | 14         | 8 UJ       | 32         | NR              |
| 25-010-TP-1 | 566        | 236        | 5.2        | 16.5       | 38.9       | 5590       | 95600      | 6.07       | 1060       | 21         | 23         | 15 J       | 143        | NR              |
| 25-010-WR-1 | 163        | 164        | 1.9        | 14.3       | 42.4       | 1050       | 29900      | 1.08       | 469        | 40         | 8          | 5 UJ       | 36         | NR              |
| BACKGROUND  | 71         | 312        | 5.6        | 13         | 18         | 224        | 15800      | 0.296      | 1570       | 15         | 156        | 9 UJ       | 240        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID       | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|----------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 25-010-TP-1    | 0.12           | 3.75                           | 132                     | 128                              | 0.09             | 0.01             | 0.02             | 0.31                             | 132                              |
| 25-010-WR-1DUP | 1.63           | 50.9                           | 456                     | 405                              | <0.01            | 0.97             | 1.62             | 30.3                             | 426                              |
| 25-010-WR-1    | 1.61           | 50.3                           | 464                     | 414                              | <0.01            | 1.37             | 1.54             | 42.8                             | 422                              |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba    | Cd     | Co     | Cr     | Cu     | Fe     | Hg      | Mn     | Ni     | Pb     | Sb     | HARDNESS CALC. Zn (mg CaCO3/L) |
|-------------|--------|-------|--------|--------|--------|--------|--------|---------|--------|--------|--------|--------|--------------------------------|
| 25-010-SW-1 | 1.61 J | 19.60 | 2.57 U | 9.70 U | 6.83 U | 3.57   | 11.8 U | 0.038 U | 4.08 U | 12.7 U | 0.72 U | 30.7 U | 7.57 U 244                     |
| 25-010-SW-2 | 2.11 J | 18.90 | 2.57 U | 9.70 U | 6.83 U | 1.55 U | 11.8 U | 0.038 U | 4.08 U | 12.7 U | 0.72 U | 30.7 U | 7.57 U 246                     |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 25-010-SW-1 | 255                    | < 5.0    | 9       | < 0.05    | < 0.01  |
| 25-010-SW-2 | 256                    | < 5.0    | 8       | < 0.05    | < 0.01  |

**LEGEND**

SE1 - Downgradient approx. 100' from last tailings pile.

SE2 - Upgradient of site approx. 100'.

TP1 - Composite of subsamples TP1A-A, 1B-A, and 1C-A.

WR1 - Composite of subsamples WR1A, 1B, 1C, 2A, and 2B.

BACKGROUND - From the Victory/Evening Star (25-010-SS-1).

WR1DUP - Duplicate of the 25-010-WR-1 sample.

SW1 - Same as sample SE1.

SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Tenmile Mine  
Legal Description: T 8N R 5W  
Mining District: Rimini  
Latitude: N 46° 28' 20"  
Longitude: W 112° 14' 30"  
Land Status: Private/Public  
Quad: Chessman Reservoir  
Inspectors: Tuesday, Belanger, Lasher  
Organization: Pioneer Technical Services, Inc.

County: Lewis and Clark  
Section(s): SE 1/4, SE 1/4, Sec. 5  
Mine Type: Hardrock/Au, Ag, Pb  
Primary Drainage: Tenmile Creek  
USGS Code: 10030101  
Secondary Drainage: Tenmile Creek  
Date Investigated: July 15, 1993  
P.A. # 25-005

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be approximately 3,040 cubic yards (not including three reclaimed dumps located in the lower section of the site). The following elements were elevated at least three times background:  
Arsenic: 1,990 to 5,530 mg/kg      Lead: 2,390 to 3,220 mg/kg  
Cadmium: 14.3 mg/kg      Zinc: 631 to 989 mg/kg  
Copper: 136 to 231 mg/kg      Mercury: 0.231 to 0.634 mg/kg
- Two adit discharges were associated with this site, a minute discharge from Adit #1 disappeared into WR-1 but did not re-emerge and was not sampled for laboratory analyses. The minor discharge from adit #5 (two gpm) exceeded the MCL for arsenic and cadmium. Acute aquatic life criteria were exceeded for cadmium and zinc and chronic aquatic life criteria were exceeded for cadmium, lead, and zinc in the Adit #5 discharge. Adit discharge pH measurements were 8.39 and 6.29 for Adit #5 and Adit #1, respectively.
- The toe of one of the reclaimed dumps was located within the Tenmile Creek floodplain.
- Logs, from a wooden ore loadout bin, were leaning downhill and may be potentially hazardous; also, WR-1 was very steep and was considered unstable. The caved upper adit (#1) blew out after this investigation.

**Tennile PA# 25-005**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 07/16/93**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 25-005-WR-1 | 1990       | 17.6       | 5          | 5.1        | 2.8        | 231        | 19900      | 0.634      | 437        | 3          | 2390       | 37 J       | 631        | NR              |
| 25-005-WR-2 | 5530       | 69.6       | 14.3       | 10.6       | 3.4        | 136        | 32000      | 0.231      | 2220       | 2 U        | 3220       | 10 J       | 989        | NR              |
| BACKGROUND  | 87 J       | 84.6       | 2.5        | 11.9       | 7.4 J      | 21 J       | 16200      | 0.053      | 1130       | 8 J        | 144 J      | 6 UJ       | 167        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID       | TOTAL SULFUR % | TOTAL SULFUR ACID BASE /1000x | NEUTRAL. POTENT. /1000x | SULFUR ACID BASE POTENT. /1000x | ORGANIC SULFUR % | PYRITIC SULFUR % | PYRITIC SULFUR ACID BASE /1000x | SULFUR ACID BASE POTENT. /1000x |
|----------------|----------------|-------------------------------|-------------------------|---------------------------------|------------------|------------------|---------------------------------|---------------------------------|
| 25-005-WR-1    | 0.17           | 5.31                          | 0.34                    | 4.97                            | 0.01             | <0.01            | 0                               | 0.34                            |
| 25-005-WR-2DUP | 0.48           | 15                            | 0.22                    | -15                             | 0.14             | 0.1              | 3.12                            | -2.9                            |
| 25-005-WR-2    | 0.47           | 14.7                          | 0.38                    | -14                             | 0.13             | 0.07             | 2.19                            | -1.81                           |

**WATER MATRIX ANALYSES**

**Metals in Water**  
**Results in ug/L**

| FIELD ID    | As     | Ba   | Cd      | Co     | Cr     | Cu    | Fe  | Hg      | Mn  | Ni     | Pb   | Sb     | Zn   | HARDNESS CALC. (mg CaCO3/L) |
|-------------|--------|------|---------|--------|--------|-------|-----|---------|-----|--------|------|--------|------|-----------------------------|
| 25-005-GW-1 | 92.7 J | 3.70 | 10.20 J | 9.70 U | 6.83 U | 10.70 | 297 | 0.038 U | 858 | 12.7 U | 13 J | 30.7 U | 2050 | 209                         |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Wet Chemistry**  
**Results in mg/l**

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 25-005-GW-1 | 335                    | < 5.0    | 157     | 0.39      | NR      |

**LEGEND**

WR1 - Composite of subsamples WR1A through 1C.  
 WR2 - Composite of subsamples WR3A, 3B, and 4.  
 BACKGROUND - From the Red Water Mine (25-007-SS-1).  
 WR2DUP - Duplicate of sample 25-005-WR-2.

GW1 - Adit #5 discharge.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Red Water  
Legal Description: T 8N R 5W  
Mining District: Rimini  
Latitude: N 46° 28' 30"  
Longitude: W 112° 14' 42"  
Land Status: Private  
Quad: Chessman Reservoir  
Inspectors: Bullock, Flammang, Clark  
Organization: Pioneer Technical Services, Inc.

County: Lewis and Clark  
Section(s): NW 1/4, Sec. 4  
Mine Type: Hardrock/Au, Ag, Pb  
Primary Drainage: Tenmile Creek  
USGS Code: 10030101  
Secondary Drainage: Tenmile Creek  
Date Investigated: July 13, 1993  
P.A. # 25-007

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be approximately 7000 cubic yards. The following elements were elevated at least three times background:

|                               |                            |
|-------------------------------|----------------------------|
| Arsenic: 4010J to 8260J mg/kg | Copper: 79.6J to 96J mg/kg |
| Mercury: 0.327 to 0.499 mg/kg | Lead: 2140J to 2290J mg/kg |
| Antimony: 43J mg/kg           | Zinc: 678 mg/kg            |
- There was one adit discharge associated with this site. The discharge flowed at approximately 29 gpm across WR-1 and then flowed into Tenmile Creek. The discharge pH was measured at 6.79 and the specific conductance was 203 umhos/cm. The adit discharge sample exceeded MCL/MCLGs for arsenic, cadmium, and antimony. The sample exceeded acute aquatic life criteria for cadmium and zinc, and chronic aquatic life criteria for cadmium, lead, and zinc.
- There was an occupied residence on the north end of this site. A sample of the residence's domestic water supply well did not exceed any of the MCLs or MCLGs.
- Tenmile Creek flowed along the base of the waste rock dumps, approximately 200 yards above a City of Helena drinking water supply intake. Surface water samples collected did not document any observed releases to the creek. There were no MCLs or MCLGs exceeded at the time of this sampling. No aquatic life criteria were exceeded that could be directly attributed to this site. The stream sediment samples collected in Tenmile Creek did document an observed release of lead.
- The discharging adit was an HMO.



**Red Water PA# 25-007**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/13/93**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 25-007-SE-1 | 350 J      | 43.6       | 5          | 6.4        | 3.6 J      | 31.3 J     | 9230       | 0.141      | 895        | 6 J        | 254 J      | 7 UJ       | 441        | NR              |
| 25-007-SE-2 | 167 J      | 21.6       | 2.6        | 4.8        | 1.3 U      | 11.1 J     | 5390       | 0.079      | 478        | 3 J        | 54 J       | 6 UJ       | 205        | NR              |
| 25-007-WR-1 | 8260 J     | 16         | 5.5        | 3.3        | 1.2 U      | 96 J       | 17200      | 0.327      | 669        | 4 J        | 2140 J     | 43 J       | 678        | NR              |
| 25-007-WR-2 | 4010 J     | 36.6       | 3.5        | 4.4        | 1.2 J      | 79.6 J     | 22400      | 0.499      | 661        | 4 J        | 2290 J     | 17 J       | 463        | NR              |
| BACKGROUND  | 87 J       | 84.6       | 2.5        | 11.9       | 7.4 J      | 21 J       | 16200      | 0.053      | 1130       | 8 J        | 144 J      | 6 UJ       | 167        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 25-007-WR-1 | 0.95           | 29.7                           | 9.27                    | -20                              | 0.45             | 0.17             | 0.33             | 5.31                             | 3.96                             |
| 25-007-WR-2 | 0.57           | 17.8                           | 2.2                     | -16                              | 0.33             | 0.05             | 0.19             | 1.56                             | 0.64                             |

**WATER MATRIX ANALYSES**

**Metals in Water**  
**Results in ug/L**

| FIELD ID    | As      | Ba    | Cd     | Co     | Cr     | Cu    | Fe      | Hg      | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|---------|-------|--------|--------|--------|-------|---------|---------|--------|--------|--------|--------|-----------------|----------------|
| 25-007-GW-1 | 131     | 41.00 | 73.90  | 13.80  | 6.83 U | 16.00 | 6160    | 0.038 U | 6250 J | 12.7 U | 1.02 J | 33.1   | 14100 J         | 190            |
| 25-007-GW-2 | 14.3    | 46.90 | 2.57 U | 9.70 U | 6.83 U | 49.30 | 11.8 U  | 0.073   | 15 J   | 12.7 U | 0.72 U | 30.7 U | 11 J            | 97             |
| 25-007-GW-3 | 12.62 J | 39.80 | 2.57 U | 9.70 U | 6.83 U | 49.40 | 20.8 JX | 0.038 U | 23.7   | 12.7 U | 3.71   | 30.7 U | 20.1 J          | 98.8           |
| 25-007-SW-1 | 3.89 J  | 11.40 | 2.57 U | 9.70 U | 6.83 U | 11.80 | 321 JX  | 0.160   | 64.4   | 12.7 U | 6.3    | 30.7 U | 201 J           | 16.2           |
| 25-007-SW-2 | 3.95 J  | 11.00 | 2.90 J | 9.70 U | 6.83 U | 11.30 | 242 JX  | 0.160   | 48.5   | 12.7 U | 3.4    | 30.7 U | 157 J           | 15.7           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Wet Chemistry**  
**Results in mg/l**

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 25-007-GW-1 | 315                    | < 5.0    | 199     | < 0.05    | NR      |
| 25-007-GW-2 | 199                    | < 5.0    | 50      | < 0.05    | NR      |
| 25-007-GW-3 | 188                    | < 5.0    | 50      | < 0.05    | NR      |
| 25-007-SW-1 | 69                     | < 5.0    | 7       | < 0.05    | NR      |
| 25-007-SW-2 | 60                     | < 5.0    | 7       | < 0.05    | NR      |

**LEGEND**

SE1 - Downgradient of site, just across from house and shed.  
 SE2 - Approx. 25' upgradient of SE end of waste rock dump 1.  
 WR1 - Composite of subsamples WR1A through 1E.  
 WR2 - Composite of subsamples WR2A, 2B, and 2C.  
 BACKGROUND - From the Red Water Mine (25-007-SS-1).

GW1 - Discharge from the mouth of adit #1.  
 GW2 - Residential well, 400' downgradient from site.  
 GW3 - QA/QC duplicate of 25-007-GW-2.  
 SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Valley Forge/Susie  
Legal Description: T 9N R 5W  
Mining District: Rimini  
Latitude: N 46° 29' 40"  
Longitude: W 112° 14' 04"  
Land Status: Private/Public  
Quad: Chessman Reservoir  
Inspectors: Bullock, Flammang, Clark  
Organization: Pioneer Technical Services, Inc.

County: Lewis and Clark  
Section(s): NE 1/4, S 1/2, Sec. 33  
Mine Type: Hardrock/Au, Ag, Pb  
Primary Drainage: Tenmile Creek  
USGS Code: 10030101  
Secondary Drainage: Tenmile Creek  
Date Investigated: July 13, 1993  
P.A. # 25-008

- This site was located in the town of Rimini.
- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be 6900 cubic yards. WR-1, the upper dump constitutes approximately 1100 cubic yards of the total volume. WR-1 was reclaimed under the MDSL Abandoned Mine Reclamation Program. WR-2 was partially covered by residential lawns and was bordered by Tenmile Creek. The following elements are elevated at least three times background:

|                        |                    |
|------------------------|--------------------|
| Arsenic: 21,500J mg/kg | Copper: 167J mg/kg |
| Mercury: 0.886 mg/kg   | Lead: 9870J mg/kg  |
| Antimony: 71J mg/kg    | Zinc: 757 mg/kg    |
- A seep emanated from the base of WR-1 and flowed along the side of WR-2 prior to discharging into Tenmile Creek. This seep was probably an adit discharge. Perforated pipe was installed in the seep area as part of the reclamation project to concentrate the flow. At the time of this investigation, the seep was flowing at approximately 20 gpm with a pH of 5.70 and a specific conductance of 379 umhos/cm. A sample collected at the discharge of the pipe exceeded MCL/MCLGs for arsenic, cadmium, and antimony, as well as acute aquatic life criteria for arsenic, iron, cadmium, and zinc, and chronic aquatic life criteria for arsenic, cadmium, mercury, and zinc.
- There was one domestic water supply well within 100 feet of WR-1. Although the water in this well exhibited a low pH (5.31) and alkalinity (0 mg/l), the sample did not exceed any of the MCLs or MCLGs.
- This site was located below the City of Helena drinking water intake. An observed release to Tenmile Creek was documented for arsenic, which was directly attributable to the site. Although several acute and chronic aquatic life criteria were exceeded for several elements in Tenmile Creek, none could be attributed to the site.

**Valley Forge/ Susie PA# 25-008**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/13/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 25-008-SE-1 | 212 J      | 42.5       | 5.3        | 7.6        | 6.3 J      | 28.1 J     | 13900      | 0.024      | 1040       | 6 J        | 181 J      | 9 UJ       | 301        | NR              |
| 25-008-SE-2 | 151 J      | 18.8       | 2.6        | 5          | 3.2 J      | 14.1 J     | 5480       | 0.036      | 619        | 3 J        | 158 J      | 6 UJ       | 220        | NR              |
| 25-008-WR-1 | 21500 J    | 103        | 5.1        | 5.2        | 2.8 J      | 167 J      | 35000      | 0.886      | 711        | 6 J        | 9870 J     | 71 J       | 757        | NR              |
| BACKGROUND  | 87 J       | 84.6       | 2.5        | 11.9       | 7.4 J      | 21 J       | 16200      | 0.053      | 1130       | 8 J        | 144 J      | 6 UJ       | 167        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 25-008-WR-1 | 1.04           | 32.5                           | 96.2                    | 63.7                             | 0.26             | 0.2              | 0.58             | 6.25                             | 90                               |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As      | Ba     | Cd      | Co     | Cr     | Cu    | Fe        | Hg      | Mn    | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|---------|--------|---------|--------|--------|-------|-----------|---------|-------|--------|------|--------|-----------------|----------------|
| 25-008-GW-1 | 27700 J | 2.01 U | 91.80 J | 64.90  | 10.20  | 33.80 | 171000 JX | 0.150   | 14500 | 43.6   | 13.2 | 53.6   | 27200 J         | 921            |
| 25-008-GW-2 | 6.72 J  | 54.00  | 2.57 U  | 9.70 U | 6.83 U | 11.00 | 491 JX    | 0.038 U | 31.4  | 12.7 U | 8.98 | 30.7 U | 20.9 J          | 250            |
| 25-008-SW-1 | 40.74 J | 10.00  | 5.17 J  | 9.70 U | 6.83 U | 12.60 | 425 JX    | 0.140   | 79.5  | 12.7 U | 4.87 | 30.7 U | 277 J           | 17.9           |
| 25-008-SW-2 | 5.61 J  | 10.60  | 4.30 J  | 9.70 U | 6.83 U | 12.70 | 233 JX    | 0.120   | 64.4  | 12.7 U | 4.55 | 30.7 U | 248 J           | 17.7           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID.   | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 25-008-GW-1 | 2010                   | < 5.0    | 1170    | < 0.05    | NR      |
| 25-008-GW-2 | 1020                   | < 5.0    | 575     | < 1.4     | NR      |
| 25-008-SW-1 | 64                     | < 5.0    | 11      | < 0.05    | NR      |
| 25-008-SW-2 | 76                     | < 5.0    | 11      | < 0.05    | NR      |

**LEGEND**

SE1 - About 25' below confluence with seep in Tennile Creek.  
 SE2 - Upstream of bridge on Tennile Creek;  
       25' upstream of waste rock dump 2.  
 WR1 - Composite of subsamples WR 2A and 2B.  
 BACKGROUND - From Red Water Mine (25-007-SS-1).

GW1 - From mouth of pipe at base of waste rock dump 1.  
 GW2 - Residential well; 100' North (downgradient).  
 SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Lower Tenmile</u>                  | County: <u>Lewis and Clark</u>            |
| Legal Description: T <u>9N</u> R <u>5W</u>            | Section(s): <u>NW 1/4, SE 1/4, Sec. 3</u> |
| Mining District: <u>Rimini</u>                        | Mine Type: <u>Hardrock/Unknown</u>        |
| Latitude: <u>N 46° 33' 52"</u>                        | Primary Drainage: <u>Tenmile Creek</u>    |
| Longitude: <u>W 112° 13' 13"</u>                      | USGS Code: <u>10030101</u>                |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Tenmile Creek</u>  |
| Quad: <u>Black Mountain</u>                           | Date Investigated: <u>July 15, 1993</u>   |
| Inspectors: <u>Tuesday, Belanger, Lasher</u>          | P.A. # <u>25-030</u>                      |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- The volume of tailings associated with this site could not be accurately determined during the investigation because the area has been completely revegetated. The volume was grossly estimated at 13,500 cubic yards. The following elements were elevated at least three times background:

|                      |                      |
|----------------------|----------------------|
| Arsenic: 3,470 mg/kg | Mercury: 0.242 mg/kg |
| Cadmium: 10.6 mg/kg  | Lead: 2,410 mg/kg    |
| Copper: 21J mg/kg    | Zinc: 654 mg/kg      |
- No MCL /MCLG exceedances were observed in groundwater or surface water samples collected at this site. Surface water, which flowed directly through the reclaimed tailings area, exceeded acute water quality criteria for copper and zinc in both upstream and downstream sample. Chronic water quality criteria were exceeded for copper, lead, and zinc in both upstream and downstream samples, indicated the presence of an upstream contaminant source.
- An observed release to surface water was documented for lead and arsenic in sediment; however, the concentration of arsenic in the surface water did not exceed any established standards. The chronic water quality criteria was exceeded for lead in both upstream and downstream samples. An observed release to groundwater was documented for zinc; however, the concentration of zinc in the groundwater did not exceed any established standards.
- Residence was located on the reclaimed tailings.



**Lower Tenmile PA# 25-030**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 7/15/93**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 25-030-SE-1 | 111        | 39.3       | 4.9        | 7.2        | 3.8        | 53.5       | 8170       | 0.141      | 801        | 3 U        | 94         | 7 UJ       | 488        | NR              |
| 25-030-SE-2 | 715        | 87.9       | 3.7        | 4.8        | 2.9        | 30.2       | 7120       | 0.111      | 837        | 2 U        | 258        | 5 UJ       | 399        | NR              |
| 25-030-TP-1 | 3470       | 27.1       | 10.6       | 3.8        | 2.8        | 88.3       | 12300      | 0.242      | 313        | 3 U        | 2410       | 17 J       | 654        | NR              |
| BACKGROUND  | 87 J       | 84.6       | 2.5        | 11.9       | 7.4 J      | 21 J       | 16200      | 0.053      | 1130       | 8 J        | 144 J      | 6 UJ       | 167        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE 1/1000t | NEUTRAL POTENT. 1/1000t | SULFUR ACID BASE POTENT. 1/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE 1/1000t | SULFUR ACID BASE POTENT. 1/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 25-030-TP-1 | 0.07           | 2.19                           | 3.39                    | 1.2                              | 0.05             | 0.01             | 0.01             | 0.31                             | 3.08                             |

**WATER MATRIX ANALYSES**

**Metals in Water**  
**Results in ug/L**

| FIELD ID    | As     | Ba    | Cd     | Co     | Cr     | Cu     | Fe  | Hg      | Mn     | Ni     | Pb     | Sb     | Zn     | HARDNESS CALC. (mg CaCO3/L) |
|-------------|--------|-------|--------|--------|--------|--------|-----|---------|--------|--------|--------|--------|--------|-----------------------------|
| 25-030-GW-1 | 25.5 J | 2.80  | 2.57 U | 9.70 U | 6.83 U | 24.80  | 92  | 0.038 U | 4.08 U | 12.7 U | 0.86 J | 30.7 U | 7.57 U | 60.6                        |
| 25-030-GW-2 | 5.30 J | 14.50 | 2.57 U | 9.70 U | 6.83 U | 1.55 U | 765 | 0.038 U | 70.4   | 12.7 U | 0.75 J | 30.7 U | 82.9   | 90.5                        |
| 25-030-SW-1 | 16.5 J | 13.50 | 2.57 U | 9.70 U | 6.83 U | 5.33   | 205 | 0.038 U | 4.08 U | 12.7 U | 2.07 J | 30.7 U | 126    | 26.4                        |
| 25-030-SW-2 | 20.4 J | 13.10 | 2.57 U | 9.70 U | 6.83 U | 5.33   | 199 | 0.038 U | 4.08 U | 12.7 U | 6.15 J | 30.7 U | 163    | 27.7                        |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Wet Chemistry**  
**Results in mg/l**

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | TOTAL CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------------|
| 25-030-GW-1 | 222                    | < 5.0    | 46      | < 0.05    | NR            |
| 25-030-GW-2 | 285                    | 9.3      | 50      | < 0.05    | NR            |
| 25-030-SW-1 | 72                     | < 5.0    | 11      | < 0.05    | NR            |
| 25-030-SW-2 | 79                     | < 5.0    | 11      | < 0.05    | NR            |

**LEGEND**

SE1 - Upgradient of tailings.

SE2 - Downgradient of tailings.

TP1 - Composite of subsamples TP1A and 1B.

BACKGROUND - From the Red Water Mine (25-007-SS-1).

GW1 - Residential well, upgradient.

GW2 - Residential well used for irrigation, downgradient.

SW1 - Same as sample SE1.

SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Armstrong</u>                      | County: <u>Lewis and Clark</u>             |
| Legal Description: T <u>8N</u> R <u>5W</u>            | Section(s): <u>NW 1/4, NW 1/4, Sec. 6</u>  |
| Mining District: <u>Rimini</u>                        | Mine Type: <u>Hardrock/Pb, Ag</u>          |
| Latitude: <u>N 46° 28' 50"</u>                        | Primary Drainage: <u>Tenmile Creek</u>     |
| Longitude: <u>W 112° 17' 13"</u>                      | USGS Code: <u>10030101</u>                 |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Minnehaha Creek</u> |
| Quad: <u>Three Brothers</u>                           | Date: <u>July 15, 1993</u>                 |
| Inspectors: <u>Bullock, Flammang, Clark</u>           | P.A. # <u>25-102</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be approximately 15,000 cubic yards. The following elements were elevated at least three times background:

|                                 |                              |
|---------------------------------|------------------------------|
| Arsenic: 1750 to 2670 mg/kg     | Copper: 300 to 470 mg/kg     |
| Mercury: 0.422J to 0.527J mg/kg | Lead: 14,000 to 15,900 mg/kg |
| Antimony: 41 to 43 mg/kg        | Zinc: 614 to 724 mg/kg       |
- There was one adit discharge associated with this site. Field parameter measurements indicated unimpaired water quality.
- Minnehaha Creek was located in the drainage approximately 300 feet below the lower mine workings. No water samples were collected because of the distance from the site and lack of surface water runoff. Sampling during early spring snow melt/runoff events could possibly document impacts to the creek. XRF screening of stream sediments indicated no impacts to the creek attributable to this site.
- There was one hazardous mine opening, the upper adit, and five hazardous structures associated with this site. There was one residence on site that appeared to be used occasionally for recreational use.

**Armstrong PA# 25-102**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/15/93**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 25-102-WR-1 | 1750          | 31.3          | 2             | 3.5           | 4.3           | 470           | 27700 J       | 0.527 J       | 339 J         | 3 U           | 15900         | 43            | 614           | NR                 |
| 25-102-WR-2 | 2670          | 26.5          | 3             | 2.1 U         | 4.1           | 300           | 30200 J       | 0.422 J       | 181 J         | 3 U           | 14000         | 41            | 724           | NR                 |
| BACKGROUND  | 87 J          | 84.6          | 2.5           | 11.9          | 7.4 J         | 21 J          | 16200         | 0.053         | 1130          | 8 J           | 144 J         | 6 UJ          | 167           | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID       | TOTAL SULFUR<br>% | TOTAL SULFUR ACID BASE<br>t/1000t | NEUTRAL POTENT.<br>t/1000t | SULFUR ACID BASE POTENT.<br>t/1000t | SULFATE SULFUR<br>% | PYRITIC SULFUR<br>% | ORGANIC SULFUR<br>% | PYRITIC SULFUR ACID BASE<br>t/1000t | SULFUR ACID BASE POTENT.<br>t/1000t |
|----------------|-------------------|-----------------------------------|----------------------------|-------------------------------------|---------------------|---------------------|---------------------|-------------------------------------|-------------------------------------|
| 25-102-WR-1    | 1.1               | 34.4                              | -2.2                       | -37                                 | 0.94                | 0.04                | 0.12                | 1.25                                | -3.43                               |
| 25-102-WR-2DUP | 1.12              | 35                                | -1.3                       | -36                                 | 0.77                | 0.1                 | 0.25                | 3.12                                | -4.4                                |
| 25-102-WR-2    | 1.1               | 34.4                              | -1.4                       | -36                                 | 0.72                | 0.09                | 0.29                | 2.81                                | -4.22                               |

**LEGEND**

WR1 - Composite of subsamples WR1A, 1B, 2A, and 2B.  
 WR2 - Composite of subsamples WR3A, 3B, 4A, and 4B.  
 BACKGROUND - From the Red Water (25-007-SS-1).  
 WR2DUP - Duplicate of sample 25-102-WR-2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Beatrice</u>                       | County: <u>Lewis and Clark</u>             |
| Legal Description: T <u>8N</u> R <u>6W</u>            | Section(s): <u>NW 1/4, NW 1/4, Sec. 1</u>  |
| Mining District: <u>Rimini</u>                        | Mine Type: <u>Hardrock/Au, Ag</u>          |
| Latitude: <u>N 46° 28' 53"</u>                        | Primary Drainage: <u>Tenmile Creek</u>     |
| Longitude: <u>W 112° 18' 10"</u>                      | USGS Code: <u>10030101</u>                 |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Minnehaha Creek</u> |
| Quad: <u>Three Brothers</u>                           | Date Investigated: <u>July 13, 1993</u>    |
| Inspectors: <u>Tuesday, Belanger, Lasher</u>          | P.A. # <u>25-103</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be approximately 5,185 cubic yards. The following elements were elevated at least three times background:

|                                 |                           |
|---------------------------------|---------------------------|
| Copper: 95.8JX to 342JX mg/kg   | Lead: 600J to 2230J mg/kg |
| Mercury: 0.265J to 0.997J mg/kg | Antimony: 65J mg/kg       |
- Three of the adits had minor discharges which, when combined, made up the majority of the flow in an unnamed tributary to Minnehaha Creek. No MCL/MCLG exceedances were observed. Acute aquatic life criteria were exceeded for iron, mercury, cadmium, copper, lead, and zinc; however, acute aquatic life criteria were exceeded for mercury, copper, and zinc in the upstream sample also. Chronic aquatic life criteria were exceeded for cadmium, copper, and zinc; however, chronic aquatic life criteria were exceeded for copper and zinc in the upstream sample. Adit discharge pH measurements were 4.34, 6.51, and 5.06 for Adit #1, Adit #2 and Adit #3, respectively. pH measurements for WR-1 seepage and WR-2 seepage were 3.81 and 6.11, respectively.
- The unnamed tributary to Minnehaha Creek cut directly through the toes of WR-1 and WR-2. This caused high turbidity and stained the streambed red. Observed releases to surface water were documented for copper and lead. Chronic aquatic life criteria exceedances for lead were attributed to the site; the exceedance for lead persisted in the sample collected farthest downstream (SW-5).
- The open shaft and open adit were accessible and potentially hazardous.



**Beatrice PA# 25-103**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 07/13/93**

**SOLID MATRIX ANALYSES**

| Metals in soils |            | Results per dry weight basis |            |            |            |            |            |            |            |            |            |            |            |                 |
|-----------------|------------|------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| FIELD ID        | As (mg/Kg) | Ba (mg/Kg)                   | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 25-103-SE-1     | 11 J       | 30.2                         | 1 J        | 5.4        | 4.3        | 64 JX      | 9330       | 0.066 J    | 608        | 19 JX      | 14 J       | 7 UJ       | 76 J       | NR              |
| 25-103-SE-3     | 33 J       | 22.5                         | 2 J        | 8.6        | 3.2        | 207 JX     | 26500      | 0.095 J    | 816        | 9 JX       | 239 J      | 14 J       | 61 J       | NR              |
| 25-103-SE-4     | 26 J       | 25.7                         | 2 J        | 16.7       | 2.6        | 242 JX     | 24300      | 0.176 J    | 1430       | 3 UJX      | 183 J      | 8 UJ       | 68 J       | NR              |
| 25-103-SE-5     | 25 J       | 11.4                         | 2.4 J      | 5.4        | 3.3        | 127 JX     | 23400      | 0.084 J    | 372        | 5 JX       | 340 J      | 9 J        | 200 J      | NR              |
| 25-103-WR-1     | 44 J       | 31.3                         | 0.7 J      | 3.1        | 3.6        | 50.2 JX    | 20000      | 0.105 J    | 88.3       | 3 UJX      | 247 J      | 7 UJ       | 28 J       | NR              |
| 25-103-WR-2     | 41 J       | 10.1                         | 0.7 J      | 2 U        | 1.4 U      | 95.8 JX    | 16700      | 0.265 J    | 88.3       | 3 UJX      | 2230 J     | 14 J       | 55 J       | NR              |
| 25-103-WR-3     | 95 J       | 17.7                         | 2.8 J      | 4.6        | 2.6        | 342 JX     | 39100      | 0.997 J    | 282        | 5 JX       | 600 J      | 65 J       | 175 J      | NR              |
| BACKGROUND      | 87 J       | 84.6                         | 2.5        | 11.9       | 7.4 J      | 21 J       | 16200      | 0.053      | 1130       | 8 J        | 144 J      | 6 UJ       | 167        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 25-103-WR-1 | 0.31           | 9.68                           | -0.9                     | -11                              | 0.19             | 0.02             | 0.1              | 0.62                             | -1.49                            |
| 25-103-WR-2 | 0.89           | 27.8                           | -1.8                     | -30                              | 0.51             | 0.08             | 0.3              | 2.5                              | -4.34                            |
| 25-103-WR-3 | 0.21           | 6.56                           | -0.8                     | -7.4                             | 0.14             | <0.01            | 0.08             | 0                                | -0.84                            |

**WATER MATRIX ANALYSES**

| Metals in Water |      | Results in ug/L |        |        |        |       |      |       |        |        |        |        |        | HARDNESS CALC. Zn (mg CaCO3/L) |
|-----------------|------|-----------------|--------|--------|--------|-------|------|-------|--------|--------|--------|--------|--------|--------------------------------|
| FIELD ID        | As   | Ba              | Cd     | Co     | Cr     | Cu    | Fe   | Hg    | Mn     | Ni     | Pb     | Sb     |        |                                |
| 25-103-SW-1     | 2.99 | 8.43            | 2.57 U | 9.70 U | 6.83 U | 9.20  | 40.1 | 0.120 | 7.57 J | 12.7 U | 0.72 U | 30.7 U | 23.4 J | 13.1                           |
| 25-103-SW-2     | 1.80 | 8.20            | 2.57 U | 9.70 U | 6.83 U | 121   | 1970 | 0.140 | 307 J  | 12.7 U | 10.4 J | 30.7 U | 95.5 J | 28.8                           |
| 25-103-SW-3     | 1.73 | 7.33            | 3.07   | 9.70 U | 6.83 U | 175   | 2710 | 0.170 | 464 J  | 12.7 U | 10.8 J | 30.7 U | 119 J  | 40.9                           |
| 25-103-SW-4     | 1.46 | 7.20            | 2.57 U | 9.70 U | 6.83 U | 156   | 2100 | 0.180 | 388 J  | 12.7 U | 7.85 J | 30.7 U | 107 J  | 41.3                           |
| 25-103-SW-5     | 2.13 | 8.63            | 2.57 U | 9.70 U | 6.83 U | 14.40 | 139  | 0.170 | 14.1 J | 12.7 U | 6.16 J | 30.7 U | 16.3 J | 13.8                           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Wet Chemistry**

**Results in mg/l**

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 25-103-SW-1 | 66                     | < 5.0    | 12      | < 0.05    | NR      |
| 25-103-SW-2 | 113                    | < 5.0    | 50      | < 0.05    | NR      |
| 25-103-SW-3 | 114                    | < 5.0    | 52      | < 0.05    | NR      |
| 25-103-SW-4 | 115                    | < 5.0    | 51      | < 0.05    | NR      |
| 25-103-SW-5 | 64                     | < 5.0    | 12      | < 0.05    | NR      |

**LEGEND**

SE1 - Upgradient of all dump and discharges.  
 SE3 - Downstream of waste rock dump 1 and adit #1.  
 SE4 - Downstream of waste rock dump 2 and adit #2.  
 SE5 - Upstream from adit #1, down from waste rock dump 4 and 5.  
 WR1 - Composite of subsamples WR1A through 1C.  
 WR2 - Composite of subsamples WR2A and 2B.  
 WR3 - Composite of subsamples WR4A through 4C.  
 BACKGROUND - From the Red Water Mine (25-007-S8-1).

SW1 - Same as sample SE1.  
 SW2 - Discharge from adit #1.  
 SW3 - Same as sample SE3.  
 SW4 - Same as sample SE4.  
 SW5 - Same as sample SE5.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Red Mountain</u>                   | County: <u>Lewis and Clark</u>                   |
| Legal Description: <u>T 8N R 5W</u>                   | Section(s): <u>SE 1/4, SW 1/4, Sec. 4</u>        |
| Mining District: <u>Rimini</u>                        | Mine Type: <u>Hardrock/Pb, Zn, Cu, Ag, Au</u>    |
| Latitude: <u>N 46° 28' 15"</u>                        | Primary Drainage: <u>Tenmile Creek</u>           |
| Longitude: <u>W 112° 13' 15"</u>                      | USGS Code: <u>10030101</u>                       |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Tenmile Creek</u>         |
| Quad: <u>Chessman Reservoir</u>                       | Date Investigated: <u>August 19 and 20, 1993</u> |
| Inspectors: <u>Bullock, Belanger, Pierson</u>         | P.A. # <u>25-019</u>                             |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |
| <u>Thomas, Dean and Hoskins, Inc.</u>                 |  |

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be approximately 13,300 cubic yards. The following elements were elevated at least three times background:

|                               |                              |
|-------------------------------|------------------------------|
| Arsenic: 3900 to 19,000 mg/kg | Mercury: 0.421 to 1.16 mg/kg |
| Lead: 2790 to 7860 mg/kg      | Antimony: 33 to 164 mg/kg    |
| Zinc: 373 to 489 mg/kg        |                              |
- The only potential adit discharge was a seep at the toe of WR-1 that discharges into the man-made flume. The flume supplied water to Chessman reservoir. This seep was discharging at a flow of less than 1 gpm, a pH of 6.67, and a specific conductance of 190 umhos/cm. The sample of this discharge exceeded the MCL for arsenic as well as the acute and chronic aquatic life criteria for cadmium, copper, lead, and zinc.
- A small intermittent tributary to Tenmile Creek contacted several of the waste rock dumps. Observed releases were documented for arsenic, lead, and zinc. No MCL/MCLGs were exceeded that were directly attributed to this site. The acute aquatic life criteria was exceeded for copper and could be directly attributed to this site.
- A water supply flume for the Chessman Reservoir crossed this site. Waste rock from WR-5 and WR-1 sluff or erode into this flume and introduced into the water supply.
- There was one open shaft that was an HMO and one hazardous structure associated with this site.

**Red Mountain (13) PA# 25-019**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/19/93**

**SOLID MATRIX ANALYSES**

| FIELD ID    | Metals in soils |            | Results per dry weight basis |            |            |            |            |            |            |            |            |            |            |    | CYANIDE (mg/Kg) |
|-------------|-----------------|------------|------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|----|-----------------|
|             | As (mg/Kg)      | Ba (mg/Kg) | Cd (mg/Kg)                   | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) |    |                 |
| 25-019-SE-1 | 54.5            | 36.6       | 1.0 UJ                       | 9.52 J     | 2.53 J     | 28.9       | 8480       | 0.04 U     | 1020       | 7.74 J     | 62.9       | 6.73 U     | 175        | NR |                 |
| 25-019-SE-2 | 67.4            | 14.1       | 1.1 UJ                       | 2.33 J     | 1.46 U     | 2.56       | 3300       | 0.032 U    | 312        | 2.56 U     | 80.8       | 7.42 U     | 50.5       | NR |                 |
| 25-019-SE-5 | 5550            | 13.1       | 1.0 UJ                       | 1.6 J      | 1.41 U     | 119        | 14000      | 0.157      | 176        | 2.46 U     | 2330       | 47.2       | 194        | NR |                 |
| 25-019-SE-6 | 84.1            | 21.7       | 1.0 UJ                       | 2.3 J      | 1.36 U     | 4.65       | 4420       | 0.058      | 691        | 2.37 U     | 129        | 6.88 U     | 73.3       | NR |                 |
| 25-019-WR-1 | 3900            | 9.22       | 1.0 UJ                       | 1.17 J     | 1.31 U     | 77.5       | 15400      | 0.421      | 49.4       | 2.3 U      | 2790       | 33         | 192        | NR |                 |
| 25-019-WR-2 | 19000           | 39.4       | 0.9 UJ                       | 1.66 J     | 1.28 U     | 23.2       | 20200      | 1.16       | 18.5       | 2.24 U     | 4080       | 55.2       | 189        | NR |                 |
| 25-019-WR-3 | 7010            | 29.1       | 0.8 UJ                       | 3.08 J     | 1.27 J     | 136        | 17900      | 0.84       | 762        | 3.17 J     | 6120       | 164        | 489        | NR |                 |
| 25-019-WR-4 | 4190            | 19         | 0.7 UJ                       | 0.82 J     | 0.98 U     | 304        | 14000      | 0.572      | 33.1       | 1.71 U     | 7860       | 93.8       | 373        | NR |                 |
| BACKGROUND  | 103             | 63.4       | 0.8 UJ                       | 6.86 J     | 4.35 J     | 15.4       | 9030       | 0.047      | 1610       | 6.69 J     | 258        | 9.78       | 117        | NR |                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL SULFUR |         | NEUTRAL POTENT. | SULFUR ACID BASE |         | SULFATE SULFUR | PYRITIC SULFUR | ORGANIC SULFUR | PYRITIC ACID BASE |         | SULFUR ACID BASE POTENT. |
|-------------|--------------|---------|-----------------|------------------|---------|----------------|----------------|----------------|-------------------|---------|--------------------------|
|             | %            | 1/1000t |                 | 1/1000t          | 1/1000t | %              | %              | %              | 1/1000t           | 1/1000t |                          |
| 25-019-WR-1 | 0.25         | 7.81    | -0.7            | -8.5             | 0.24    | <0.01          | 0.01           | 0              | 0                 | -0.67   |                          |
| 25-019-WR-2 | 1.92         | 60      | -3.6            | -64              | 0.6     | 0.92           | 0.4            | 28.7           | 28.7              | -32.3   |                          |
| 25-019-WR-3 | 0.56         | 17.5    | -1.4            | -19              | 0.34    | 0.04           | 0.18           | 1.25           | 1.25              | -2.63   |                          |
| 25-019-WR-4 | 0.62         | 19.4    | -2.7            | -22              | 0.47    | 0.02           | 0.13           | 0.62           | 0.62              | -3.34   |                          |

**WATER MATRIX ANALYSES**

| FIELD ID    | Metals in Water |      | Results in ug/L |       |        |        |      |        |      |        |        |        |        |      | HARDNESS CALC. Zn (mg CaCO3/L) |
|-------------|-----------------|------|-----------------|-------|--------|--------|------|--------|------|--------|--------|--------|--------|------|--------------------------------|
|             | As              | Ba   | Cd              | Co    | Cr     | Cu     | Fe   | Hg     | Mn   | Ni     | Pb     | Sb     |        |      |                                |
| 25-019-GW-1 | 71.2            | 2.27 | 3.63            | 9.7 U | 6.83 U | 14.2 J | 489  | 0.12 U | 1020 | 16.5 J | 52.6 J | 30.7 U | 1470 J | 44.4 |                                |
| 25-019-SW-1 | 11.8            | 3.2  | 2.57 U          | 9.7 U | 6.83 U | 1.55 U | 165  | 0.12 U | 20.9 | 12.7 U | 3.36 J | 30.7 U | 23.2 J | 9    |                                |
| 25-019-SW-2 | 13              | 2.9  | 2.57 U          | 9.7 U | 6.83 U | 1.55 U | 159  | 0.12 U | 4.73 | 12.7 U | 2.39 J | 30.7 U | 18.6 J | 7.8  |                                |
| 25-019-SW-3 | 45.8            | 5.33 | 15.4            | 9.7 U | 6.83 U | 199 J  | 1210 | 0.23 J | 1230 | 21.8 J | 58.2 J | 30.7 U | 2700 J | 27   |                                |
| 25-019-SW-4 | 3.66            | 4.27 | 2.57 U          | 9.7 U | 6.83 U | 1.63 J | 223  | 0.2 J  | 7.57 | 12.7 U | 3.49 J | 30.7 U | 23.2 J | 8    |                                |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Wet Chemistry**

**Results in mg/l**

| FIELD I.D.  | TOTAL DISSOLVED SOLIDS |   | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|---|----------|---------|-----------|---------|
|             |                        |   |          |         |           |         |
| 25-019-GW-1 | 19                     | < | 5.0      | 40      | <         | 0.05    |
| 25-019-SW-1 | 56                     | < | 5.0      | 5       | <         | 0.05    |
| 25-019-SW-2 | 48                     | < | 5.0      | <       | 5         | <       |
| 25-019-SW-3 | 116                    | < | 5.0      | 53      | 0.2       |         |
| 25-019-SW-4 | 45                     | < | 5.0      | <       | 5.0       |         |

**LEGEND**

SE1 - Downgradient of waste rock dump 1, 2, and 3.  
 SE2 - Upgradient of waste rock dumps 1, 2, and 3.  
 SE5 - Downgradient with sample SW3.  
 SE6 - Upgradient with sample SW4.  
 WR1 - Composite of subsamples WR1, 2A, and 2B.  
 WR2 - Sample of the WR3 subsample.  
 WR3 - Composite of the subsamples WR4A, 4B, 5, 6A, and 6B.  
 WR4 - Composite of the subsamples WR7A, 7B, 7C, 8A, and 8B.  
 BACKGROUND - From the Red Mountain Mine (25-019-SB-1).

GW1 - Seepage from waste rock dump 1.  
 SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.  
 SW3 - Downgradient at Red Mountain N.  
 SW4 - Upgradient, above aqueduct at Red Mountain N.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Upper Valley Forge</u>             | County: <u>Lewis and Clark</u>             |
| Legal Description: T <u>9N</u> R <u>5W</u>            | Section(s): <u>SE 1/4, NW 1/4, Sec. 33</u> |
| Mining District: <u>Rimini</u>                        | Mine Type: <u>Hardrock/Au, Ag, Pb</u>      |
| Latitude: <u>N 46° 29' 30"</u>                        | Primary Drainage: <u>Tenmile Creek</u>     |
| Longitude: <u>W 112° 14' 28"</u>                      | USGS Code: <u>10030101</u>                 |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Tenmile Creek</u>   |
| Quad: <u>Chessman Reservoir</u>                       | Date Investigated: <u>August 20, 1993</u>  |
| Inspectors: <u>Bullock, Belanger/Pierson</u>          | P.A. # <u>25-280 and 25-282</u>            |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |
| <u>/Thomas, Dean &amp; Hoskins, Inc.</u>              |  |

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be approximately 13,000 cubic yards. The following elements were elevated at least three times background:

|                                |                               |
|--------------------------------|-------------------------------|
| Arsenic: 5380 to 121,000 mg/kg | Copper: 134 to 645 mg/kg      |
| Iron: 108,000                  | Mercury: 0.477 to 0.691 mg/kg |
| Lead: 7360 to 48,700 mg/kg     | Antimony: 80.1 to 826 mg/kg   |
| Zinc: 685J mg/kg               |                               |
- There was one adit in the upper workings that may discharge during a spring snow-melt period. Water accumulated near the adit had a pH of 5.7 and a specific conductance of 560 umhos/cm.
- A small seep emanated from the toe of WR-1 and then flowed into the unnamed tributary to Tenmile Creek. At the time of this investigation, the seep discharge was less than 1 gpm, with a pH of 2.66 and a specific conductance of 2720 umhos/cm. The discharge exceeded MCL/MCLGs for arsenic, cadmium, copper, nickel, and antimony. Acute and chronic aquatic life criteria were exceeded for arsenic, cadmium, copper, lead, and zinc. The acute standard was also exceeded for iron.
- Observed releases were documented in the unnamed tributary for arsenic, copper, iron, lead, and zinc. The MCL exceedance for arsenic was attributable to this site. Acute and chronic aquatic life criteria were exceeded for arsenic, copper, lead, and zinc; all directly attributable to this site except for the chronic criteria exceedance for lead, which was also exceeded in the upstream sample. This unnamed tributary entered Tenmile Creek downstream from the City of Helena drinking water intake.



**Upper Valley Forge PA# 25-280 and 25-282**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/20/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 25-280-SE-1 | 6340       | 38.3 J     | 29 J       | 17.9 J     | 6.32       | 414        | 28100      | 0.192      | 4040 J     | 3.95 U     | 2150       | 31.1       | 1610 J     | NR              |
| 25-280-SE-2 | 92.6       | 37.7 J     | 2.7 J      | 3.37 J     | 7.25       | 14.3       | 9160       | 0.031 U    | 412 J      | 4.63       | 98.6       | 6.41 U     | 233 J      | NR              |
| 25-280-WR-1 | 27200      | 8.13 J     | 5.7 J      | 2.2 J      | 2.48       | 134        | 30900      | 0.477      | 575 J      | 2.47 U     | 7360       | 88.2       | 685 J      | NR              |
| 25-280-WR-2 | 5380       | 16.5 J     | 0.5 U      | 1.94 J     | 3.35       | 222        | 21200      | 0.386      | 28.7 J     | 2.38 U     | 8080       | 80.1       | 287 J      | NR              |
| 25-280-WR-3 | 121000     | 1.82 J     | 1.7 J      | 3.81 J     | 1.33 U     | 645        | 108000     | 0.691      | 7.86 J     | 2.47 U     | 48700      | 826        | 171 J      | NR              |
| BACKGROUND  | 87 J       | 84.6       | 2.5        | 11.9       | 7.4 J      | 21 J       | 16200      | 0.053      | 1130       | 8 J        | 144 J      | 6 UJ       | 167        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 25-280-WR-1 | 1.82           | 56.9                           | 4.25                     | -53                              | 0.86             | 0.4              | 0.56             | 12.5                             | -8.25                            |
| 25-280-WR-2 | 2.07           | 64.7                           | -3.7                     | -68                              | 0.65             | 0.87             | 0.55             | 27.2                             | -30.9                            |
| 25-280-WR-3 | 9.29           | 290                            | -4.7                     | 295                              | <0.01            | 2.79             | 11.8             | 87.2                             | -91.8                            |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | Results in µg/L |        |        |       |        |        |          |        |       |        |      |        |                 | HARDNESS |  |
|-------------|-----------------|--------|--------|-------|--------|--------|----------|--------|-------|--------|------|--------|-----------------|----------|--|
|             | As              | Ba     | Cd     | Co    | Cr     | Cu     | Fe       | Hg     | Mn    | Ni     | Pb   | Sb     | CALC.           |          |  |
|             |                 |        |        |       |        |        |          |        |       |        |      |        | Zn (mg CaCO3/L) |          |  |
| 25-280-GW-1 | 23700 J         | 2.01 U | 818    | 127   | 24.3 J | 3710 J | 184000 J | 0.12 U | 21700 | 112    | 2150 | 33.6   | 83300           | 381      |  |
| 25-280-SW-1 | 609 J           | 13.3   | 38.2   | 9.7 U | 6.83 U | 160 J  | 6820 J   | 0.12 U | 1560  | 15.3   | 101  | 30.7 U | 5320            | 116      |  |
| 25-280-SW-2 | 13.1 J          | 24.5   | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 72.6 J   | 0.12 U | 7.8   | 12.7 U | 2.07 | 30.7 U | 47.2            | 67.5     |  |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested; ND - No Data

Wet Chemistry  
Results in mg/l

| FIELD ID.   | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 25-280-GW-1 | 2310                   | ND       | 1330    | < 0.05    | < 0.01  |
| 25-280-SW-1 | 235                    | < 5.0    | 134     | < 0.05    | < 0.01  |
| 25-280-SW-2 | 138                    | < 5.0    | 28      | < 0.05    | NR      |

**LEGEND**

SE1 - Approx. 120' downgradient of waste rock dump 1.  
below confluence with seep.  
SE2 - Upgradient of site.  
WR1 - Composite of subsamples WR1A, 1B, 1C, 2A, 2B, and 3.  
WR2 - Composite of subsamples WR4 and 5.  
WR3 - Sample of the WR6 subsample.  
BACKGROUND - From the Red Water Mine (25-007-SS-1).

GW1 -  
SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: SE SE S13  
Legal Description: T 8N R 6W  
Mining District: Rimini  
Latitude: N 46° 26' 12"  
Longitude: W 112° 17' 12"  
Land Status: Public  
Quad: Three Brothers  
Inspectors: Bullock, Belanger/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Lewis and Clark  
Section(s): SE 1/4, SE 1/4, Sec. 13  
Mine Type: Placer/Au  
Primary Drainage: Tenmile Creek  
USGS Code: 10030101  
Secondary Drainage: Monitor Creek  
Date Investigated: August 19, 1993  
P.A. # 25-294

- There were no mill tailings or waste rock associated with this site.
- The volume of placer tailings associated with this site was estimated to be approximately 22,000 cubic yards. Sampling was focused on whether mercury contamination associated with amalgamation processes existed. Samples were collected from sediments underlying the rock piles. Mercury was the only element that exceeded the background sample by more than three times, but was not attributed directly to this site.
- Surface water samples collected in Monitor Creek did not document any observed releases. There were no MCL/MCLGs exceeded. Aquatic life criteria were exceeded for cadmium, copper, lead, and zinc in both the upstream and downstream samples, making the exceedances impossible to attribute to this site. There were also no observed releases documented from the sediment data.
- Active mining operations were in progress upstream from this site and may have been responsible for the aquatic life criteria exceedances as well as the visual impacts to Monitor Creek which included heavy sediment loading and an orange, iron-like precipitate.

**SE SE Section 13 PA# 25-294**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/19/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 25-294-SE-1 | 9.48 J     | 7.44 J     | 0.6 U      | 2.18 U     | 1.53 U     | 8.5 J      | 5290 J     | 0.056 J    | 62.2 J     | 2.84 U     | 59.4 J     | 6.88 U     | 31.1 J     | NR              |
| 25-294-SE-2 | 10.3 J     | 6.37 J     | 0.6 U      | 2.42 U     | 2.25       | 7.68 J     | 5560 J     | 0.126 J    | 34.3 J     | 3.16 U     | 29 J       | 7.66 U     | 25.9 J     | NR              |
| 25-294-SE-3 | 5.86 J     | 12.1 J     | 0.5 U      | 1.96 U     | 1.39       | 4.5 J      | 3570 J     | 0.212 J    | 80.3 J     | 2.56 U     | 15 J       | 6.2 U      | 52.2 J     | NR              |
| BACKGROUND  | 87 J       | 84.6       | 2.5        | 11.9       | 7.4 J      | 21 J       | 16200      | 0.053      | 1130       | 8 J        | 144 J      | 6 UJ       | 167        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd   | Co    | Cr     | Cu     | Fe  | Hg     | Mn  | Ni     | Pb     | Sb     | Zn    | HARDNESS CALC. (mg CaCO3/L) |
|-------------|--------|------|------|-------|--------|--------|-----|--------|-----|--------|--------|--------|-------|-----------------------------|
| 25-294-SW-1 | 1.51   | 29.3 | 4.37 | 9.7 U | 6.83 U | 13.2 J | 261 | 0.12 U | 118 | 12.7 U | 10.5 J | 30.7 U | 264 J | 22                          |
| 25-294-SW-2 | 1.49 U | 32.8 | 4.73 | 9.7 U | 6.83 U | 15.5 J | 300 | 0.12 U | 139 | 17.4 J | 11.6 J | 30.7 U | 299 J | 23.6                        |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 25-294-SW-1 | 81                     | < 5.0    | 29      | 0.16      | NR      |
| 25-294-SW-2 | 83                     | < 5.0    | 33      | 0.16      | NR      |

**LEGEND**

SE1 - Sediment downgradient on Monitor Creek.  
SE2 - Sediment upgradient on Monitor Creek.  
SE3 - Placer tailings in seepage drainage.  
BACKGROUND - From the Red Water (25-007-SS-1).

SW1 - Downgradient on Monitor Creek.  
SW2 - Upgradient on Monitor Creek.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |  |
|--|--|
| Mine/Site Name: <u>Franklin</u>  | County: <u>Lewis and Clark</u>             |
| Legal Description: T <u>10N</u> R <u>4W</u>  | Section(s): <u>SE 1/4, NW 1/4, Sec. 11</u> |
| Mining District: <u>Scratch Gravel</u>   | Mine Type: <u>Hardrock/Ag. Cu, Au, Pb</u>  |
| Latitude: <u>N 46° 38' 22"</u>   | Primary Drainage: <u>Tenmile Creek</u>     |
| Longitude: <u>W 112° 04' 25"</u>   | USGS Code: <u>10030101</u>                 |
| Land Status: <u>Private</u>  | Secondary Drainage: <u>Tenmile Creek</u>   |
| Quad: <u>Scratchgravel Hills</u>   | Date Investigated: <u>August 31, 1993</u>  |
| Inspectors: <u>Tuesday, Flammang/Pierson</u>   | P.A. # <u>25-339</u>                       |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |  |

- The volume of tailings associated with this site was estimated to be 1,100 cubic yards. The following elements were elevated at least three times background:

|                     |                   |
|---------------------|-------------------|
| Cadmium: 5.22 mg/kg | Lead: 1,250 mg/kg |
| Copper: 199 mg/kg   | Zinc: 832 mg/kg   |
- The volume of waste rock associated with this site was estimated to be 10,110 cubic yards. The following elements were elevated at least three times background:

|                            |                               |
|----------------------------|-------------------------------|
| Arsenic: 223 mg/kg         | Lead: 358 to 6,170 mg/kg      |
| Cadmium: 4.10 mg/kg        | Zinc: 314 mg/kg               |
| Copper: 128 to 1,190 mg/kg | Mercury: 0.257 to 0.612 mg/kg |
| Antimony: 22.6 mg/kg       |                               |
- The volume of CN heap leach material associated with this site was estimated to be 10,000 cubic yards. The concentration of cyanide in the material was measured at 0.366 mg/kg; additionally, the following elements were elevated at least three times background:

|                     |                 |
|---------------------|-----------------|
| Cadmium: 3.00 mg/kg | Zinc: 372 mg/kg |
| Copper: 142 mg/kg   | Lead: 502 mg/kg |
- There were no adit discharges, seeps, springs, or streams associated with this site. A grate placed over the shaft disallowed sampling of groundwater.
- Five potentially hazardous structures and one caving shaft were located on site. The majority of site was enclosed by barbed wire fences and locked gates.



**Franklin Mine PA# 25-339**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER-TUESDAY**  
**INVESTIGATION DATE: 8/31/93**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 25-339-LP-1 | 12.2          | 75.6          | 3.00          | 8.5           | 3.39          | 142           | 25800         | 0.164         | 1360          | 7.8           | 502           | < 6.15        | 372           | 0.366              |
| 25-339-LP-3 | NR            | NR            | NR            | NR            | NR            | NR            | NR            | NR            | NR            | NR            | NR            | NR            | NR            | 0.666              |
| 25-339-TP-1 | 71.7          | 33            | 5.22          | 5.86          | 7.11          | 199           | 17500         | 0.079         | 617           | 5.35          | 1250          | < 6.19        | 832           | NR                 |
| 25-339-WR-1 | 223           | 29.6          | 4.10          | 4.79          | 2.91          | 1190          | 37200         | 0.612         | 689           | 5.61          | 6170          | 22.6          | 314           | NR                 |
| 25-339-WR-2 | 13.8          | 78.4          | 0.74          | 6.35          | 2.64          | 128           | 22500         | 0.257         | 968           | 3.31          | 358           | < 5.11        | 117           | NR                 |
| BACKGROUND  | 27.1          | 165           | 1.32          | 13.6          | 17.9          | 29.7          | 23300         | 0.071         | 672           | 17.9          | 36.3          | < 6.98        | 76.4          | NR                 |

U - Not Detected; I - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | TOTAL SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | PYRITIC<br>SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|-------------------------------|---|------------------------|------------------------|------------------------|---|--|
| 25-339-LP-1 | 0.45              | 14.1                                 | 22                            | 7.92  | 0.04                   | 0.05                   | 0.36                   | 1.56                                      | 20.4   |
| 25-339-LP-3 | 0.2               | 6.25                                 | 119                           | 112   | 0.08                   | 0.04                   | 0.08                   | 1.25                                      | 117  |
| 25-339-TP-1 | 0.29              | 9.06                                 | 7.03                          | -2  | 0.15                   | 0.03                   | 0.11                   | 0.94                                      | 6.09   |
| 25-339-WR-1 | 4.6               | 144                                  | -5.5                          | -149  | 2.23                   | 1.4                    | 0.97                   | 43.7                                      | -49.2  |
| 25-339-WR-2 | 1.18              | 36.9                                 | 2.95                          | -34   | 0.64                   | <0.01                  | 0.56                   | 0   | 2.95   |

**LEGEND**

LP1 - Composite of subsamples LP1A, 1B, and 2.

LP3 - Sample of LP3.

WR1 - Composite of the subsamples WR1 and 3A through 3D.

WR2 - Composite of subsamples 2A through 2C and 5.

BACKGROUND - On ridge SE of waste rock dump 1 and SW of WR2C.

TP1 - Composite of subsamples TP1A and 1B.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>NE NW S13</u>                      | County: <u>Lewis and Clark</u>             |
| Legal Description: T <u>13N</u> R <u>7W</u>           | Section(s): <u>NE 1/4, NW 1/4, Sec. 13</u> |
| Mining District: <u>Stemple</u>                       | Mine Type: <u>Millsite/Unknown</u>         |
| Latitude: <u>N 46° 53' 33"</u>                        | Primary Drainage: <u>Virginia Creek</u>    |
| Longitude: <u>W 112° 26' 08"</u>                      | USGS Code: <u>10030101</u>                 |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Fool Hen Creek</u>  |
| Quad: <u>Stemple Pass</u>                             | Date Investigated: <u>August 30, 1993</u>  |
| Inspectors: <u>M. Babits, S. Babits</u>               | P.A. # <u>25-197</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- The volume of tailings associated with this site was estimated to be approximately 175,000 cubic yards. The following elements were elevated at least three times background:  
Lead: 256J mg/kg
- No waste rock was observed at this site during the investigation.
- One discharging adit was identified at the site. At the time of the site visit, this flowing adit made up the entire flow in Fool Hen Creek. Surface water and sediment samples were collected upstream and downstream from the site in Fool Hen Creek. The MCL for arsenic was exceeded in the downstream sample; however, this exceedance was not attributable to the site. An observed release to Fool Hen Creek was documented for lead. Acute and chronic aquatic life criteria were exceeded for copper in the upstream sample. The chronic aquatic life criteria for lead was exceeded in the downstream sample, which was directly attributable to the site.
- Potential safety hazards identified at the site included an open adit and five collapsing cabins.

**NE NW Section 13 PA# 25-197**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/30/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 25-197-SE-2 | 4.97 U     | 42.2 JX    | 1.1 J      | 1.04 U     | 6.89       | 18.9       | 2680       | 5.66 JX    | 239        | 2.26 U     | 59.9 J     | 6.57 UJ    | 72.3       | 2.61            |
| 25-197-TP-1 | 10.5       | 124 JX     | 1.8 J      | 2.48       | 17.5       | 33.3       | 6140       | 1.55 JX    | 599        | 7.43 J     | 87.1 J     | 5.65 UJ    | 195        | NR              |
| 25-197-TP-2 | 13.7       | 134 JX     | 3.5 J      | 1.55       | 17.9       | 78         | 7250       | 0.313 JX   | 1260       | 6.55 J     | 256 J      | 7.12 UJ    | 317        | 2.2             |
| BACKGROUND  | 21.3       | 145 JX     | 1.4 J      | 5.28       | 8.61       | 29.6       | 11900      | 0.758 JX   | 889        | 12.3 J     | 60.3 J     | 8.01 UJ    | 121        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID       | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|----------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 25-197-TP-1    | <0.01          | 0                              | 139                     | 139                              | <0.01            | <0.01            | 0.01             | 0                                | 139                              |
| 25-197-TP-1DUP | <0.01          | 0                              | 138                     | 138                              | <0.01            | <0.01            | 0.01             | 0                                | 138                              |
| 25-197-TP-2    | 0.47           | 14.7                           | 2.58                    | -12                              | 0.3              | 0.14             | 0.03             | 4.37                             | -1.8                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba  | Cd     | Co    | Cr     | Cu     | Fe      | Hg     | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|-----|--------|-------|--------|--------|---------|--------|--------|--------|--------|--------|-----------------|----------------|
| 25-197-SW-1 | 5.83 J | 416 | 2.57 U | 9.7 U | 13.3 J | 31.3 J | 11.8 UX | 0.12 U | 4.08 U | 12.7 U | 2.55 J | 30.7 U | 7.57 U          | 116            |
| 25-197-SW-2 | 90.8 J | 396 | 2.57 U | 9.7 U | 6.83 U | 4.9 J  | 73.2 JX | 0.12 U | 26.8   | 12.7 U | 24.5 J | 30.7 U | 7.57 U          | 116            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 25-197-SW-1 | 119                    | <        | 5       | 0.13      | < 0.005 |
| 25-197-SW-2 | 127                    | <        | 5       | 0.08      | < 0.005 |

**LEGEND**

SE2 - Downgradient (75') from tailings pond 1 in Fool Hen Creek.

SW2 - Same as sample SE2.

TP1 - Composite of subsamples TP1A-A, 1A-B, and 1B-A.

TP2 - Composite of subsamples TP1A-C, 1B-B, and 1B-C.

BACKGROUND - From SE SW Sec. 10 (25-212-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Swansea Tailings/Mine  
Legal Description: T 13N R 7W  
Mining District: Stemple  
Latitude: N 46° 53' 27"  
Longitude: W 112° 32' 17"  
Land Status: Private  
Quad: Swede Gulch  
Inspectors: Bullock, M. Babits, S. Babits,  
Flammang, Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Lewis and Clark  
Section(s): NW 1/4, NE 1/4, Sec. 18  
Mine Type: Hardrock/Au, Ag, Pb, Cu  
Primary Drainage: Poorman Creek  
USGS Code: 17010201  
Secondary Drainage: Swansea Gulch  
Date Investigated: September 1, 1993  
P.A. # 25-208

- The volume of tailings associated with this site was estimated to be approximately 3700 cubic yards. The following elements were elevated at least three times background:  
Cadmium: 25 mg/kg                      Copper: 2010JX mg/kg  
Lead: 2510 mg/kg                      Antimony: 39.1J mg/kg  
Zinc: 503J mg/kg
- The volume of waste rock associated with this site was estimated to be approximately 15,000 cubic yards. The following elements were elevated at least three times background:  
Cadmium: 6 to 14 mg/kg                      Copper: 1050JX to 1910JX mg/kg  
Mercury: 0.179JX to 0.736JX mg/kg                      Manganese: 1130 mg/kg  
Lead: 361 to 1610 mg/kg                      Antimony: 22.5J mg/kg  
Zinc: 239J to 629J mg/kg
- There was one discharging adit associated with this site. The water discharging from the adit had a neutral pH (7.29) and did not exceed and MCL/MCLGs or aquatic life criteria.
- There were no observed releases to Swansea Gulch based on the surface water samples collected during this investigation. No exceedances of MCL/MCLGs or aquatic life criteria attributable to this site were documented. The surface water and sediment data collected did indicate a possible upstream source of contaminants that was not identified during this investigation. Spring runoff or storm event sampling would probably document releases from this site due to uncontained contaminant sources in the drainage.



**Swansea Tailings PA# 25-208**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 09/01/93**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 25-208-SE-1 | 19.1 J     | 61 J       | 6.3        | 3.15 J     | 13.2 J     | 1160 JX    | 5730       | 0.047 UX   | 146        | 7.92 J     | 863        | 11.8 J     | 275 J      | NR              |
| 25-208-SE-2 | 4.24 U     | 67.6 J     | 0.8 U      | 4.22 J     | 16.7 J     | 15.2 JX    | 8190       | 0.031 UX   | 291        | 11.6 J     | 24.2       | 5.6 UJ     | 49.3 J     | NR              |
| 25-208-TP-1 | 49.5 J     | 29.5 J     | 25.0       | 1.59 J     | 6.44 J     | 2010 JX    | 5230       | 0.033 UX   | 183        | 3.46 J     | 2510       | 39.1 J     | 503 J      | 4.14            |
| 25-208-WR-1 | 32.8 J     | 67.9 J     | 6.4        | 4.77 J     | 16.5 J     | 1050 JX    | 7760       | 0.179 JX   | 285        | 12.1 J     | 815        | 22.5 J     | 217 J      | NR              |
| 25-208-WR-2 | 22.5 J     | 173 J      | 13.4       | 8.38 J     | 19.4 J     | 1910 JX    | 13900      | 0.318 JX   | 1130       | 22.4 J     | 1610       | 5.97 UJ    | 629 J      | NR              |
| 25-208-WR-3 | 8.2 J      | 80.6 J     | 13.5       | 4.34 J     | 14.8 J     | 361 JX     | 7230       | 0.736 JX   | 425        | 14.2 J     | 361        | 5.66 UJ    | 239 J      | NR              |
| BACKGROUND  | 19.5 J     | 168 J      | 1 U        | 9.67 J     | 36.5 J     | 228 JX     | 12800      | 0.033 UX   | 468        | 30.4 J     | 34.4       | 6.95 UJ    | 66.9 J     | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID       | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|----------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 25-208-TP-1    | <0.01          | 0                              | 3.23                    | 3.23                             | <0.01            | <0.01            | <0.01            | 0                                | 3.23                             |
| 25-208-WR-1    | <0.01          | 0                              | 9.64                    | 9.64                             | <0.01            | 0.01             | <0.01            | 0.31                             | 9.33                             |
| 25-208-WR-2DUP | <0.01          | 0                              | 8.18                    | 8.18                             | <0.01            | <0.01            | <0.01            | 0                                | 8.18                             |
| 25-208-WR-2    | <0.01          | 0                              | 8.42                    | 8.42                             | <0.01            | <0.01            | <0.01            | 0                                | 8.42                             |
| 25-208-WR-3    | <0.01          | 0                              | 37.3                    | 37.3                             | <0.01            | 0.01             | <0.01            | 0.31                             | 37                               |

**WATER MATRIX ANALYSES**

**Metals in Water**  
**Results in ug/L**

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu     | Fe      | Hg     | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|--------|-------|--------|--------|---------|--------|--------|--------|--------|--------|-----------------|----------------|
| 25-208-SW-1 | 7.15 J | 62.9 | 2.57 U | 9.7 U | 11.9 J | 21.3 J | 265 JX  | 0.12 U | 17.5   | 12.7 U | 4.32 J | 30.7 U | 9.5             | 90.9           |
| 25-208-SW-2 | 3.92 J | 88.8 | 2.57 U | 9.7 U | 12.6 J | 15.2 J | 19.4 JX | 0.12 U | 4.13   | 12.7 U | 2.53 J | 30.7 U | 7.6             | 79.2           |
| 25-208-SW-3 | 1.18 U | 91.4 | 4.59 U | 5 U   | 6.24 U | 2.33 U | 14.7    | 0.12 U | 3.76 U | 10.9 U | 0.82   | 31.7 U | 11.5            | 73.6           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Wet Chemistry**  
**Results in mg/l**

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 25-208-SW-1 | 117                    | <        | 5       | 10        | 0.11    |
| 25-208-SW-2 | 106                    | <        | 5       | 9         | 0.07    |
| 25-208-SW-3 | 77                     | <        | 5       | 5         | 0.15    |

**LEGEND**

SE1 - Upgradient of mine and confluence, 40' up from road crossing.  
 SE2 - Swansea Gulch; downgradient of waste rock dump 5.  
 TP1 - Composite of subsamples TP1A-A through 1A-C.  
 WR1 - Composite of subsamples WR1, 2A, 2B, 3A, and 3B.  
 WR2 - Composite of subsamples WR4A through 4D.  
 WR3 - Composite of subsamples WR5A and 5B.  
 BACKGROUND - From the Swansea Tailings (25-208-SS-1).  
 WR2DUP - Duplicate of the 25-208-WR-2 sample.

SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.  
 SW3 - Adit discharge at waste rock dump 5.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>SE SW S10</u>                      | County: <u>Lewis and Clark</u>             |
| Legal Description: T <u>13N</u> R <u>7W</u>           | Section(s): <u>SE 1/4, SW 1/4, Sec. 10</u> |
| Mining District: <u>Stemple</u>                       | Mine Type: <u>Millsite/Unknown</u>         |
| Latitude: <u>N 46° 53' 38"</u>                        | Primary Drainage: <u>Canyon Creek</u>      |
| Longitude: <u>W 112° 28' 45"</u>                      | USGS Code: <u>10030101</u>                 |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Virginia Creek</u>  |
| Quad: <u>Stemple Pass</u>                             | Date Investigated: <u>August 30, 1993</u>  |
| Inspectors: <u>M. Babits, S. Babits</u>               | P.A. # <u>25-212</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- The volume of tailings associated with this site was estimated to be approximately 2,750 cubic yards. The following elements were elevated at least three times background:  
Copper: 92.8 mg/kg      Mercury: 8.15JX mg/kg  
Lead: 215J mg/kg
- No waste rock was observed at the site during the investigation.
- No discharging adits, filled shafts, seeps, or springs were identified at the site.
- No surface water or sediment samples were collected during the investigation, due to the lack of direct runoff routes to surface water located nearest to the site.
- No hazardous mine openings were identified at the site; however, the mill building was collapsing and potentially hazardous.

**SE SW Section 10 PA# 25-212**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/30/93**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 25-212-TP-1 | 47.6          | 278 JX        | 2.9 J         | 5.86          | 4.24          | 92.8          | 14300         | 8.15 JX       | 803           | 11.7 J        | 215 J         | 6.28 UJ       | 190           | 0.305 U            |
| BACKGROUND  | 21.3          | 145 JX        | 1.4 J         | 5.28          | 8.61          | 29.6          | 11900         | 0.758 JX      | 889           | 12.3 J        | 60.3 J        | 8.01 UJ       | 121           | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL.<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|----------------------|---|--------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 25-212-TP-1 | <0.01                | 0                                       | 170                            | 170                                       | <0.01                  | <0.01                  | <0.01                  | 0   | 170                                       |

**LEGEND**

TP1 - Composite of subsamples TP1A-A, 1B-A, and 1B-B.  
 BACKGROUND - On East side of Virginia Creek.  
 From SE SW Sec. 10 (25-212-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Pangewasset</u>                    | County: <u>Lewis and Clark</u>             |
| Legal Description: T <u>13N</u> R <u>7W</u>           | Section(s): <u>SE 1/4, SE 1/4, Sec. 15</u> |
| Mining District: <u>Stemple</u>                       | Mine Type: <u>Hardrock/Au</u>              |
| Latitude: <u>N 46° 52' 40"</u>                        | Primary Drainage: <u>Virginia Creek</u>    |
| Longitude: <u>W 112° 28' 03"</u>                      | USGS Code: <u>10030101</u>                 |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Gould Creek</u>     |
| Quad: <u>Stemple Pass</u>                             | Date Investigated: <u>August 31, 1993</u>  |
| Inspectors: <u>M. Babits, S. Babits</u>               | P.A. # <u>25-226</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- The volume of tailings associated with this site was estimated to be approximately 1,700 cubic yards; however, no metals concentrations were elevated above background.
- The volume of waste rock associated with this site was estimated to be approximately 14,000 cubic yards; however, no metals concentrations were elevated significantly above background.
- No discharging adits, filled shafts, seeps, or springs were identified at the site.
- No surface water was identified on or near the site. The nearest surface water was located approximately 350 feet from the site; consequently, no surface water or sediment samples were collected.
- Potential safety hazards identified at the site included one open adit and five collapsing cabins.



**Pangewasset PA# 25-226**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/31/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 25-226-TP-1 | 4.33 U        | 10.6 JX       | 0.8 U         | 1.08          | 2.33          | 7.81          | 2430          | 0.626 JX      | 83.7          | 2.06 J        | 8.93 J        | 5.72 UJ       | 17.1          | 0.263 U            |
| 25-226-WR-1 | 14.8          | 274 JX        | 0.8 J         | 4.53          | 5.13          | 30.6          | 10400         | 0.693 JX      | 369           | 8.98 J        | 32.9 J        | 4.6 UJ        | 68.7          | NR                 |
| BACKGROUND  | 21.3          | 145 JX        | 1.4 J         | 5.28          | 8.61          | 29.6          | 11900         | 0.758 JX      | 889           | 12.3 J        | 60.3 J        | 8.01 UJ       | 121           | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 25-226-TP-1 | <0.01             | 0                                    | 78.1                          | 78.1                                      | <0.01                  | <0.01                  | <0.01                  | 0   | 78.1                                      |
| 25-226-WR-1 | <0.01             | 0                                    | 109                           | 109                                       | <0.01                  | <0.01                  | 0.01                   | 0   | 109                                       |

**LEGEND**

TP1 - Composite of subsamples TP1A, 1B, and 1C.  
WR1 - Composite of subsamples WR1A, 1B, and 1C.  
BACKGROUND - From SE SW Sec. 10 (25-212-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Astor</u><br>Legal Description: T <u>13N</u> R <u>7W</u><br>Mining District: <u>Stemple</u><br>Latitude: <u>N 46° 52' 34"</u><br>Longitude: <u>W 112° 26' 54"</u><br>Land Status: <u>Private/Public</u><br>Quad: <u>Stemple Pass</u><br>Inspectors: <u>M. Babits, S. Babits</u><br>Organization: <u>Pioneer Technical Services, Inc.</u> | County: <u>Lewis and Clark</u><br>Section(s): <u>NE 1/4, NE 1/4, Sec. 23</u><br>Mine Type: <u>Hardrock/Unknown</u><br>Primary Drainage: <u>Virginia Creek</u><br>USGS Code: <u>10030101</u><br>Secondary Drainage: <u>Gould Creek</u><br>Date Investigated: <u>August 31, 1993</u><br>P.A. # <u>25-227</u> |
|---|--|

- The volume of tailings associated with this site was estimated to be approximately 2 cubic yards. Due to the extremely small volume, no samples were collected for laboratory analysis.
- The volume of waste rock associated with this site was estimated to be approximately 25,000 cubic yards; however, no metals concentrations were elevated significantly above background.
- One discharging adit was identified at the site; the adit discharge entered Gould Creek after flowing through the waste rock pile located on site. No MCLs were exceeded in the adit discharge; however, the chronic aquatic life criteria for lead. The adit discharge pH measurement was 7.65.
- Surface water and sediment samples were collected upstream and downstream from the site in Gould Creek. No MCLs were exceeded; however, the chronic aquatic life criteria for mercury was exceeded in both upstream and downstream samples. The chronic aquatic life criteria for lead was exceeded in the downstream sample. Concentrations of barium, cobalt, copper, iron, nickel, and lead were elevated (>3X) in the downstream sediment sample, compared to the upstream sediment sample.
- No hazardous mine openings were identified at the site.

**Astor PA# 25-227**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/31/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 25-227-SE-1 | 7.15       | 51.8 JX    | 1.7 J      | 2.47       | 5.41       | 23         | 6980       | 15.1 JX    | 200        | 3.06 J     | 65.7 J     | 6.26 UJ    | 103        | 0.314 U         |
| 25-227-SE-2 | 19         | 187 JX     | 3.7 J      | 9.12       | 11.4       | 104        | 21700      | 17.7 JX    | 552        | 13.2 J     | 231 J      | 12.5 UJ    | 221        | 0.672 U         |
| 25-227-WR-1 | 48.7       | 84.1 JX    | 2.0 J      | 8.62       | 3.14       | 80.5       | 28500      | 0.203 JX   | 946        | 3.71 J     | 149 J      | 4.88 UJ    | 155        | NR              |
| BACKGROUND  | 21.3       | 145 JX     | 1.4 J      | 5.28       | 8.61       | 29.6       | 11900      | 0.758 JX   | 889        | 12.3 J     | 60.3 J     | 8.01 UJ    | 121        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 25-227-WR-1 | <0.01          | 0                              | 40.2                     | 40.2                             | <0.01            | <0.01            | <0.01            | 0                                | 40.2                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu     | Fe      | Hg     | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|--------|-------|--------|--------|---------|--------|--------|--------|--------|--------|-----------------|----------------|
| 25-227-SW-1 | 7.24 J | 76.3 | 2.57 U | 9.7 U | 6.83 U | 9.3 J  | 51.7 JX | 0.14   | 11.7   | 12.7 U | 3.01 J | 30.7 U | 7.57 U          | 115            |
| 25-227-SW-2 | 13.4 J | 61.9 | 2.57 U | 9.7 U | 6.83 U | 11.7 J | 121 JX  | 0.78   | 12.6   | 12.7 U | 5.9 J  | 30.7 U | 13.5            | 115            |
| 25-227-SW-3 | 16.8 J | 9.8  | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 101 JX  | 0.12 U | 4.08 U | 12.7 U | 5.08 J | 30.7 U | 7.57 U          | 90.1           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID.   | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 25-227-SW-1 | 139                    | < 5      | 5       | < 0.05    | < 0.005 |
| 25-227-SW-2 | 128                    | < 5      | 7       | < 0.05    | < 0.005 |
| 25-227-SW-3 | 120                    | < 5      | 6       | 0.09      | NR      |

**LEGEND**

SE1 - Upgradient (175') in Gould Creek (mill building).  
SE2 - Downgradient (270') in Gould Creek (cabin).  
WR1 - Composite of subsamples WR1A, 1B, and 1C.  
BACKGROUND - From SE SW Sec.10 (25-212-SS-1).

SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.  
SW3 - Adit discharge at waste rock dump 1.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Snowshoe  
Legal Description: T 28N R 31W  
Mining District: Libby  
Latitude: N 48° 12' 17"  
Longitude: W 115° 38' 42"  
Land Status: Private  
Quad: Showshoe Peak  
Inspectors: Tuesday, Belanger, Lasher  
Organization: Pioneer Technical Services, Inc.

County: Lincoln  
Section(s): NE 1/4, NW 1/4, Sec. 7  
Mine Type: Hardrock/Pb, Zn, Ag  
Primary Drainage: Snowshoe Creek  
USGS Code: 17010101  
Secondary Drainage: Snowshoe Creek  
Date Investigated: August 4, 1993  
P.A. # 27-005

- The volume of tailings associated with this site was estimated to be approximately 5,000 cubic yards. The tailings were located within the floodplain of Snowshoe Creek. The following elements were elevated at least three times background:

|                       |                     |
|-----------------------|---------------------|
| Arsenic: 3,840J mg/kg | Mercury: 0.4 mg/kg  |
| Cadmium: 142 mg/kg    | Lead: 44,300 mg/kg  |
| Copper: 664 mg/kg     | Antimony: 109 mg/kg |
| Iron: 98,200 mg/kg    | Zinc: 11,700 mg/kg  |
- The volume of waste rock associated with this site was estimated to be approximately 3,990 cubic yards. Some reclamation had been done on the lower dump (WR4). The following elements were elevated at least three times background:

|                      |                     |
|----------------------|---------------------|
| Arsenic: 3,230 mg/kg | Mercury: 1.11 mg/kg |
| Cadmium: 81.8 mg/kg  | Lead: 59,300 mg/kg  |
| Copper: 545 mg/kg    | Antimony: 120 mg/kg |
| Iron: 64,400 mg/kg   | Zinc: 6,530 mg/kg   |
- There were no adit discharges associated with the site; however, an intermittent tributary to perennial Snowshoe Creek ran through the site. The tributary had a trickle of flow during the investigation which exceeded the MCL for cadmium. The downstream sample in Snowshoe creek also exceeded the MCL for cadmium. Acute aquatic life criteria were exceeded for cadmium, lead, and zinc in the tributary and Snowshoe Creek. Chronic aquatic life criteria were exceeded for cadmium, mercury, lead, and zinc in the tributary and Snowshoe Creek.
- Observed releases to Snowshoe Creek were documented for arsenic, cadmium, iron, lead, and zinc. The aquatic life criteria exceedances and the MCL exceedances for cadmium can be directly attributed to the site.
- The three open adits and several steep, unstable waste piles were accessible and potentially hazardous.



**Snowshoe PA# 27-005**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 08/04/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 27-005-SE-1 | 17.2 J     | 12.5       | 1.09       | 5.63       | 1.46       | 10.1       | 15700      | 0.04       | 308        | 5.2        | 21.4       | 6.29 U     | 45.5       | NR              |
| 27-005-SE-2 | 1350 J     | 6.45       | 115        | 7.82       | 1.78       | 226        | 78700      | 0.037      | 4580       | 5.4        | 8320       | 32.2       | 9270       | NR              |
| 27-005-TP-1 | 3840 J     | 4.91       | 142        | 5.52       | 1.58 U     | 664        | 98200      | 0.4        | 1150       | 2.93 U     | 44300      | 109        | 11700      | NR              |
| 27-005-WR-1 | 3230 J     | 7.58       | 81.8       | 8.44       | 1.73       | 545        | 64400      | 1.11       | 1120       | 6.16       | 59300      | 120        | 6530       | NR              |
| BACKGROUND  | 54.2 J     | 18.5       | 1.23       | 9.23       | 1.59 U     | 29.4       | 21400      | 0.061      | 475        | 11.8       | 198        | 7.15 U     | 213        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 27-005-TP-1 | 1.62           | 50.6                           | 3.74                    | -46.9                            | 0.09             | 1.23             | 0.30             | 38.4                             | -34.7                            |
| 27-005-WR-1 | 1.71           | 53.4                           | 15.5                    | -37.9                            | 0.18             | 0.55             | 0.98             | 17.2                             | -1.67                            |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As      | Ba   | Cd     | Co    | Cr     | Cu   | Fe     | Hg       | Mn     | Ni     | Pb     | Sb     | Zn     | HARDNESS CALC. (mg CaCO3/L) |
|-------------|---------|------|--------|-------|--------|------|--------|----------|--------|--------|--------|--------|--------|-----------------------------|
| 27-005-SW-1 | 0.987 J | 2.97 | 2.57 U | 9.7 U | 6.83 U | 1.67 | 35.1 J | 0.180 JX | 4.08 U | 12.7 U | 1.22 U | 30.7 U | 7.57 U | 39.1                        |
| 27-005-SW-2 | 4.43 J  | 4.63 | 14     | 9.7 U | 6.83 U | 2.77 | 45.2 J | 0.210 JX | 48.1   | 12.7 U | 60.7 J | 30.7 U | 1030 J | 41.7                        |
| 27-005-SW-3 | 9.06 J  | 4.47 | 61.5   | 9.7 U | 6.83 U | 4.97 | 191 J  | 0.220 JX | 175    | 12.7 U | 82.3 J | 30.7 U | 5940 J | 98.5                        |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 27-005-SW-1 | 55                     | < 5.0    | < 5.0   | 0.07      | NR      |
| 27-005-SW-2 | 53                     | < 5.0    | 8       | 0.1       | NR      |
| 27-005-SW-3 | 152                    | < 5.0    | 42      | 0.07      | NR      |

**LEGEND**

SE1 - Upgradient of mine in Snowshoe Creek.  
SE2 - Downstream of mine and most floodplain tailings.  
TP1 - In floodplain near base of mines.  
BACKGROUND - From Snowshoe Mine (27-005-SS-1).

SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.  
SW3 - Discharge from pipe under dump.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Cherry Creek Millsite  
Legal Description: T 29N R 31W  
Mining District: Libby  
Latitude: N 48° 14' 42"  
Longitude: W 115° 32' 50"  
Land Status: Public  
Quad: Cable Mountain  
Inspectors: Tuesday, Belanger, Lasher  
Organization: Pioneer Technical Services, Inc.

County: Lincoln  
Section(s): SE 1/4, NW 1/4, Sec. 27  
Mine Type: Millsite/Unknown  
Primary Drainage: Libby Creek  
USGS Code: 17010101  
Secondary Drainage: Big Cherry Creek  
Date Investigated: August 4, 1993  
P.A. # 27-006

- The volume of tailings associated with this site was estimated to be approximately 4,540 cubic yards. The tailings have been reclaimed and were moderately to well vegetated. The concentration of cyanide measured in the tailings was 0.867 mg/kg; additionally, the following elements were elevated at least three times background:

|                     |                      |
|---------------------|----------------------|
| Arsenic: 546J mg/kg | Lead: 10,500 mg/kg   |
| Cadmium: 22.5 mg/kg | Antimony: 39.2 mg/kg |
| Copper: 399 mg/kg   | Zinc: 5,780 mg/kg    |
| Mercury: 0.89 mg/kg |                      |
- There were no adit discharges or seeps associated with this site. Big Cherry Creek flowed approximately 50 feet east of the site; however, no surface water samples were collected during the investigation. Three sediment samples were collected from Big Cherry Creek corresponding to upstream, probable point of entry, and downstream locations. An observed release to surface water was documented for arsenic in sediments.
- No groundwater samples were collected at this site during the investigation.
- The partially vegetated tailings that contained high concentrations of arsenic and lead were easily accessible by recreationalists.

**Cherry Creek Mill PA# 27-006**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 08/04/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 27-006-SE-1 | 143 J      | 19.3       | 6.43       | 5.89       | 3.19       | 22.7       | 20500      | 0.02       | 777        | 9.55       | 795        | 6.82       | 616        | NR              |
| 27-006-SE-2 | 470 J      | 22.4       | 15.4       | 7.44       | 3.49       | 33.8       | 62000      | 0.029      | 2720       | 8.07       | 1740       | 7.51       | 1150       | NR              |
| 27-006-SE-3 | 199 J      | 16.7       | 8.57       | 5.12       | 2.79       | 42.7       | 40100      | 0.025      | 1790       | 7.11       | 1180       | 6.73 U     | 822        | NR              |
| 27-006-TP-1 | 546 J      | 35.7       | 22.5       | 4.12       | 2.62       | 399        | 30300      | 0.89       | 384        | 5.39       | 10500      | 39.2       | 5780       | 0.867           |
| BACKGROUND  | 54.2 J     | 18.5       | 1.23       | 9.23       | 1.59 U     | 29.4       | 21400      | 0.061      | 475        | 11.8       | 198        | 7.15 U     | 213        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 27-006-TP-1 | 0.30           | 9.37                           | 2.09                    | -7.28                            | 0.14             | 0.11             | 0.05             | 3.44                             | -1.34                            |

**LEGEND**

SE1 - Upgradient on Cherry Creek.  
SE2 - PPE to Cherry Creek.  
SE3 - Downgradient on Cherry Creek.  
TP1 - Sample of the subsample TP1A-B.  
BACKGROUND - From the Snowshoe Mine (27-005-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Mitchell Creek</u>                 | County: <u>Lincoln</u>                     |
| Legal Description: T <u>31N</u> R <u>31W</u>          | Section(s): <u>SW 1/4, SE 1/4, Sec. 25</u> |
| Mining District: <u>Libby</u>                         | Mine Type: <u>Hardrock/Unknown</u>         |
| Latitude: <u>N 48° 24' 57"</u>                        | Primary Drainage: <u>Kootenai River</u>    |
| Longitude: <u>W 115° 29' 55"</u>                      | USGS Code: <u>17010101</u>                 |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>None</u>            |
| Quad: <u>Vermiculite Mountain</u>                     | Date Investigated: <u>August 4, 1993</u>   |
| Inspectors: <u>Bullock, Flammang, Clark</u>           | P.A. # <u>27-055</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be 200 cubic yards. Copper (137 mg/kg) was the only element elevated at least three times background. The waste rock dump was mostly unvegetated.
- No adit discharges, seeps or springs were observed at this site.
- The one adit on-site was open and classified a hazardous mine opening.

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**Mitchell Creek PA# 27-055**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/04/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 27-055-WR-1 | 5.63 J        | 121           | 0.47 U        | 6.22          | 4.55          | 137           | 9140          | 0.027         | 509           | 11.8          | 10.5          | 5.64 U        | 30.1          | NR                 |
| BACKGROUND  | 54.2 J        | 18.5          | 1.23          | 9.23          | 1.59 U        | 29.4          | 21400         | 0.061         | 475           | 11.8          | 198           | 7.15 U        | 213           | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 27-055-WR-1 | 0.01              | 0.31                                 | 3.82                          | 3.51                                      | 0.01                   | <0.01                  | <0.01                  | 0.00                                      | 3.82                                      |

**LEGEND**

WR1 - Composite of subsamples WR1A and 1B.  
BACKGROUND - From the Snowshoe Mine (27-005-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Silver Cable</u>                   | County: <u>Lincoln</u>                           |
| Legal Description: T <u>28N</u> R <u>31W</u>          | Section(s): <u>NW 1/4, NW 1/4, Sec. 32</u>       |
| Mining District: <u>Libby</u>                         | Mine Type: <u>Hardrock/Pb</u>                    |
| Latitude: <u>N 48° 08' 42"</u>                        | Primary Drainage: <u>Big Cherry Creek</u>        |
| Longitude: <u>W 115° 37' 48"</u>                      | USGS Code: <u>17010101</u>                       |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Cable Creek</u>           |
| Quad: <u>Snowshoe Peak</u>                            | Date Investigated: <u>Aug 4 and Sept 7, 1993</u> |
| Inspectors: <u>Bullock, Flammang, Clark</u>           | P.A. # <u>27-066</u>                             |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- The mine was located on a mountainside well above (800 to 1,000 feet) the Cable Creek drainage; however, no samples were collected due to inaccessibility of the workings. There appeared to be a good vegetative cover on the dumps, and no direct migration routes to surface water.
- The literature reported that a small mill was constructed for this mine, but never operated. No evidence of the mill was found during the investigation.
- One potentially hazardous mine opening (adit) was identified at the site.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Boaz</u>                           | County: <u>Madison</u>                          |
| Legal Description: <u>T 3S R 1E</u>                   | Section(s): <u>NW 1/4, SW 1/4, Sec. 19</u>      |
| Mining District: <u>Norris/Red Bluff</u>              | Mine Type: <u>Hardrock/Au, Pb, Zn, Ag</u>       |
| Latitude: <u>N 45° 33' 35"</u>                        | Primary Drainage: <u>Hot Springs Creek</u>      |
| Longitude: <u>W 111° 39' 16"</u>                      | USGS Code: <u>10020007</u>                      |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Unnamed tributary of</u> |
| Quad: <u>Norris</u>                                   | <u>Hot Springs Creek</u>                        |
| Inspectors: <u>M. Babits, S. Babits</u>               | Date Investigated: <u>September 13, 1993</u>    |
| Organization: <u>Pioneer Technical Services, Inc.</u> | P.A. # <u>29-013</u>                            |

- The volume of tailings associated with this site was estimated to be approximately 56,500 cubic yards. The following elements were elevated at least three times background:

|                                 |                                |
|---------------------------------|--------------------------------|
| Arsenic: 95.1J to 127J mg/kg    | Cadmium: 12.8 to 18 mg/kg      |
| Copper: 205 to 241 mg/kg        | Mercury: 0.536J to 1.26J mg/kg |
| Manganese: 1,130 to 1,810 mg/kg | Lead: 3,030 to 4,800 mg/kg     |
| Zinc: 1,710 to 2,440 mg/kg      | Cyanide: 0.445 to 2.21 mg/kg   |
- The volume of waste rock associated with this site was estimated to be approximately 138,770 cubic yards. The following elements were elevated at least three times background:

|                     |                        |
|---------------------|------------------------|
| Cadmium: 2.06 mg/kg | Manganese: 1,220 mg/kg |
| Lead: 576 mg/kg     | Zinc: 399 mg/kg        |
- No discharging adits, filled shafts, seeps, or springs were identified at the site.
- An unnamed tributary to Hot Springs Creek flowed directly through the tailings at the site and eventually discharged into wetlands. Surface water and sediment samples were collected in the tributary upstream and downstream from the site. An observed release to the tributary was documented for lead; and the chronic aquatic life criteria for lead was exceeded in the downstream sample. The upstream sample indicated the presence of an upstream source.
- Two potentially hazardous open adits were identified at the site. The on site shaft had previously been grated by MDSL-AMRB.



**Boaz PA# 29-013**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 09/13/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 29-013-SE-1 | 6.74 J     | 119        | 0.94 U     | 8.27       | 35.4       | 26.6       | 16400      | 0.114 J    | 190        | 25         | 6.75       | 6.5 UJ     | 50.3       | NR              |
| 29-013-SE-2 | 16.7 J     | 70.9       | 1.66       | 5.52       | 14.8       | 38.3       | 10400      | 0.159 J    | 337        | 12.2       | 596        | 6.08 UJ    | 330        | NR              |
| 29-013-TP-1 | 95.1 J     | 230        | 12.80      | 9.04       | 32.4       | 205        | 29600      | 0.536 J    | 1130       | 31.1       | 3030       | 6.41 UJ    | 1710       | 2.21            |
| 29-013-TP-2 | 127 J      | 303        | 18.00      | 11.6       | 41.1       | 241        | 40900      | 1.26 J     | 1810       | 35.2       | 4800       | 6.81 J     | 2440       | 0.445           |
| 29-013-WR-1 | 25.2 J     | 253        | 2.06       | 12.8       | 53.8       | 54.2       | 27200      | 0.157 J    | 1220       | 44         | 576        | 5.44 UJ    | 399        | NR              |
| BACKGROUND  | 11.4       | 105        | 0.4 U      | 12.8       | 34.3       | 31.3       | 22100      | 0.11 J     | 363 J      | 26.7       | 6.81 U     | 5.18 U     | 43.1       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 29-013-TP-1 | 1.25           | 39                             | 48.3                     | 9.28                             | 0.24             | 0.84             | 0.17             | 26.2                             | 22.1                             |
| 29-013-TP-2 | 0.68           | 21.2                           | 45.3                     | 24                               | 0.14             | 0.45             | 0.09             | 14.1                             | 31.2                             |
| 29-013-WR-1 | <0.01          | 0                              | 51.4                     | 51.4                             | <0.01            | <0.01            | 0.05             | 0                                | 51.4                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co  | Cr     | Cu     | Fe   | Hg     | Mn   | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|------|--------|-----|--------|--------|------|--------|------|--------|------|--------|-----------------|----------------|
| 29-013-SW-1 | 3.69 | 102  | 4.59 U | 5 U | 6.24 U | 3.47   | 1610 | 0.14 J | 71.8 | 28.3   | 1.38 | 31.7 U | 35              | 129            |
| 29-013-SW-2 | 3.9  | 95.6 | 4.59 U | 5 U | 6.24 U | 2.33 U | 73.1 | 0.12 U | 5.27 | 10.9 U | 15.6 | 31.7 U | 13.8            | 142            |

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 29-013-SW-1 | 190                    | <        | 5       | 11        | 0.29    |
| 29-013-SW-2 | 196                    | <        | 5       | 11        | 0.05    |

**LEGEND**

SE1 - 180 feet upgradient from tailings pond 1.  
SE2 - 10 feet downgradient from tailings pond 2.  
TP1 - Composite of subsamples TP1A-A, 1A-B, 1A-C, and TP-2A.  
TP2 - Composite of subsamples TP1A-D, 1A-E, 1B-B, and TP-2B.  
WR1 - Composite of subsamples WR1A, 1B, 2, and 3.  
BACKGROUND - From the Grubstake (29-399-SS-1).

SW1 - Same as SE1.  
SW2 - Same as SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |   |
|--|---|
| Mine/Site Name: <u>Grubstake</u>   | County: <u>Madison</u>                                  |
| Legal Description: <u>T 3S R 1E</u>  | Section(s): <u>SE 1/4, SE 1/4, Sec. 19</u>              |
| Mining District: <u>Norris/Red Bluff</u>   | Mine Type: <u>Hardrock/Au</u>                           |
| Latitude: <u>N 45° 33' 23"</u>   | Primary Drainage: <u>Hot Springs Creek</u>              |
| Longitude: <u>W 111° 38' 30"</u>   | USGS Code: <u>10020007</u>                              |
| Land Status: <u>Private</u>  | Secondary Drainage: <u>South Fork Hot Springs Creek</u> |
| Quad: <u>Norris</u>  | Date Investigated: <u>July 22, 1993</u>                 |
| Inspectors: <u>Babits, Lasher/Pierson</u>  | P.A. # <u>29-399</u>                                    |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |   |

- There were approximately 5,780 cubic yards of uncovered tailings at the site. The following were elevated at least 3 times background:
  - Arsenic: 52 to 63.4 mg/kg
  - Cadmium: 4 to 10 mg/kg
  - Copper: 101 to 148 mg/kg
  - Mercury: 0.331J mg/kg
  - Manganese: 1,360 mg/kg
  - Lead: 566 to 1,690 mg/kg
  - Zinc: 588 to 1,340 mg/kg
  - Cyanide: 22.3 to 40.3 mg/kg
- There were approximately 1,030 cubic yards of uncovered waste rock at the site. The following were elevated at least 3 times background:
  - Arsenic: 65 mg/kg
  - Cadmium: 4 mg/kg
  - Lead: 417 mg/kg
  - Zinc: 546 mg/kg
- There were no discharging adits at the site.
- An dry intermittent drainage was on the site. No surface water samples were collected, but sediment samples were collected. There were no observed releases to downstream sediments; however, cyanide was detected in one downstream sediment sample (SE-3).
- There was one open shaft at the site.

**Grubstake PA# 29-399**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/22/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 29-399-SE-1 | 28.3          | 275           | 2.1           | 24.5          | 81.1          | 58.8          | 29200         | 0.246 J       | 711 J         | 78.3          | 81.1          | 5.51 U        | 133           | NR                 |
| 29-399-SE-2 | 14            | 125           | 1.6           | 12.4          | 28.4          | 36.5          | 16600         | 0.064 J       | 439 J         | 26.3          | 81            | 6 U           | 109           | 0.387              |
| 29-399-SE-3 | 20.6          | 226           | 1.6           | 19.2          | 48.4          | 54            | 27800         | 0.145 J       | 563 J         | 45.6          | 156           | 5.46 U        | 213           | 0.295 U            |
| 29-399-TP-1 | 52            | 117           | 4.3           | 11            | 34.9          | 54.3          | 21800         | 0.122 J       | 727 J         | 33            | 566           | 5.65 U        | 588           | 10.6               |
| 29-399-TP-2 | 63.4          | 267           | 9.9           | 18.3          | 51.2          | 148           | 36600         | 0.331 J       | 1360 J        | 55.3          | 1690          | 5.7 U         | 1340          | 40.3               |
| 29-399-TP-3 | 54.9          | 247           | 9.4           | 15.2          | 42.9          | 101           | 30600         | 0.199 J       | 994 J         | 38.8          | 1450          | 6.99 U        | 1220          | 22.3               |
| 29-399-WR-1 | 65            | 161           | 3.9           | 21.7          | 61.3          | 72.6          | 32500         | 0.289 J       | 901 J         | 65.3          | 417           | 5.33 U        | 546           | NR                 |
| BACKGROUND  | 11.4          | 105           | 0.4 U         | 12.8          | 34.3          | 31.3          | 22100         | 0.11 J        | 363 J         | 26.7          | 6.81 U        | 5.18 U        | 43.1          | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 29-399-TP-1 | 0.48              | 15                                   | 34.7                          | 19.7                                      | 0.1                    | 0.19                   | 0.19                   | 5.94                                      | 28.8                                      |
| 29-399-TP-2 | 0.53              | 16.6                                 | 53.8                          | 37.2                                      | <0.01                  | 0.9                    | 0.12                   | 28.1                                      | 25.6                                      |
| 29-399-TP-3 | 0.57              | 17.8                                 | 41.3                          | 23.5                                      | 0.19                   | 0.23                   | 0.15                   | 7.19                                      | 34.2                                      |
| 29-399-WR-1 | 0.29              | 9.06                                 | 48.9                          | 39.8                                      | <0.01                  | 0.15                   | 0.15                   | 4.69                                      | 44.2                                      |

**LEGEND**

SE1 - Background sediment.  
SE2 - At outfall of culvert below tailings pond 5.  
SE3 - Next dam below tailings pond 5.  
TP1 - Composite of subsamples TP1A, 1B, 2A, and 3A.  
TP2 - Composite of subsamples TP4A and 5A.  
TP3 - Composite of subsamples TP4B and 5B.  
WR1 - Composite of subsamples WR1A, 1B, and 2.  
BACKGROUND - From the Grubstake (29-399-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Norwegian  
Legal Description: T 3S R 2W  
Mining District: Norwegian  
Latitude: N 45° 36' 20"  
Longitude: W 111° 48' 50"  
Land Status: Private  
Quad: Maltbys Mound  
Inspectors: M. Babits, S. Babits  
Organization: Pioneer Technical Services, Inc.

County: Madison  
Section(s): NW 1/4, SE 1/4, Sec. 2  
Mine Type: Hardrock/Au, Ag  
Primary Drainage: Norwegian Creek  
USGS Code: 10020005  
Secondary Drainage: Preacher Creek  
Date Investigated: September 13, 1993  
P.A. # 29-006

- The volume of tailings associated with this site was estimated to be approximately 1,010 cubic yards. The following elements were elevated at least three times background:  
Copper: 382 mg/kg                      Lead: 122 mg/kg
- The volume of waste rock associated with this site was estimated to be approximately 2,290 cubic yards. The following elements were elevated at least three times background:  
Cobalt: 15.7 mg/kg                      Copper: 226 mg/kg  
Nickel: 18.7 mg/kg                      Lead: 172 mg/kg
- No discharging adits, filled shafts, seeps, or springs were identified at the site.
- No surface water was identified on or near the site. The nearest surface water was located more than 1,200 feet away; consequently, no surface water or sediment samples were collected.
- Two potentially hazardous partially collapsed shafts were identified at the site.



**Norwegian PA# 29-006**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 09/13/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 29-006-TP-1 | 8.67 J        | 102           | 0.94 U        | 10.4          | 11.3          | 382           | 29100         | 0.138 J       | 788           | 11.5          | 122           | 6.48 UJ       | 100           | 0.867              |
| 29-006-WR-1 | 6.65 J        | 139           | 0.83 U        | 15.7          | 17.9          | 226           | 24600         | 0.236 J       | 817           | 18.7          | 172           | 5.74 UJ       | 42            | NR                 |
| BACKGROUND  | 10.6 J        | 102           | 0.94 U        | 4.2           | 8.69          | 23.9          | 18500         | 0.105 J       | 395           | 4.04          | 14.7          | 6.46 UJ       | 46.7          | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL.<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|--------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 29-006-TP-1 | 0.03              | 0.94                                 | 6.48                           | 5.54                                      | 0.02                   | <0.01                  | 0.01                   | 0   | 6.48                                      |
| 29-006-WR-1 | 0.06              | 1.87                                 | 10.8                           | 8.88                                      | 0.01                   | 0.01                   | 0.04                   | 0.31                                      | 10.4                                      |

**LEGEND**

TP1 - Composite of subsamples TP1B-A, 1A-A, 1A-B, 1A-C, 1B-B, and 1B-C.  
WR1 - Composite of subsamples WR 1, 2, 3, and 4.  
BACKGROUND - From Norwegian Mine (29-006-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Atlantic/Pacific  
Legal Description: T 2S R 3W  
Mining District: Pony  
Latitude: N 45° 38' 50"  
Longitude: W 111° 59' 20"  
Land Status: Private/Public  
Quad: Pony  
Inspectors: M. Babits, S. Babits, Flammang  
Organization: Pioneer Technical Services, Inc.

County: Madison  
Section(s): E 1/2, Sec. 20; W 1/2, Sec. 21  
Mine Type: Hardrock/Ag. Au  
Primary Drainage: South Boulder River  
USGS Code: 10020005  
Secondary Drainage: Park Creek  
Date Investigated: September 16 and 18, 1993  
P.A. # 29-033

- The volume of tailings associated with this site was estimated to be approximately 64,500 cubic yards. The following elements were elevated at least three times background:  
Lead: 69.9 mg/kg
- The volume of waste rock associated with this site was estimated to be approximately 19,000 cubic yards. The following elements were elevated at least three times background:  
Cobalt: 34.9 mg/kg                      Copper: 91 mg/kg  
Manganese: 6,710 mg/kg              Lead: 156 mg/kg
- A soil sample collected at the base of the heap leach pad revealed a cyanide concentration of 16.1 mg/kg, and a water sample collected from a lined impoundment revealed 0.75 mg/l cyanide.
- One discharging adit was identified at the site. MCLs and acute and chronic aquatic life criteria were exceeded for cadmium and copper in the adit discharge. Additionally, the chronic aquatic life criteria for iron was exceeded. The adit discharge pH measurement was 3.6.
- Park Creek flowed adjacent to the site on the west site. Surface water and sediment samples were collected upstream and downstream from the site. An observed release to Park Creek was documented for lead. Acute and chronic aquatic life criteria for copper were exceeded in the downstream sample, and the chronic aquatic life criteria for lead was exceeded in the downstream sample.
- Three potentially hazardous open adits were identified at the site.

**Atlantic & Pacific PA# 29-033**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 09/14/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 29-033-SE-1 | 6.04 U     | 36.9       | 1.2 U      | 3.42       | 12.7       | 19.1       | 6290       | 0.034 U    | 123 J      | 15.1       | 8.28 U     | 7.99 UJ    | 15         | NR              |
| 29-033-SE-2 | 6.25 U     | 55.7       | 1.2 U      | 3.29       | 4.53       | 17.6       | 8190       | 0.038 U    | 256 J      | 7.5        | 8.57 U     | 8.27 UJ    | 8.9        | NR              |
| 29-033-TP-1 | 5.16 U     | 103        | 1.0 U      | 2.31       | 1.93       | 21.8       | 10600      | 0.049      | 173 J      | 2.35 U     | 27         | 6.83 UJ    | 5.41       | NR              |
| 29-033-TP-2 | 4.05 U     | 187        | 0.8 U      | 1.88       | 2.74       | 18         | 19000      | 0.099      | 85.6 J     | 1.99       | 69.9       | 5.35 UJ    | 6.19       | 0.102 U         |
| 29-033-WR-1 | 4.98       | 145        | 0.8 U      | 7.43       | 3.85       | 61.6       | 19400      | 0.025 U    | 521 J      | 5.71       | 156        | 5.31 UJ    | 13.6       | NR              |
| 29-033-WR-2 | 4.76 U     | 256        | 0.9 U      | 34.9       | 1.37       | 91         | 15500      | 0.242      | 6710 J     | 7.08       | 17.6       | 6.3 UJ     | 15.7       | NR              |
| 29-033-SS-1 | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         | 16.1            |
| 29-033-SS-2 | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         | 0.609           |
| BACKGROUND  | 20.1 J     | 168        | 0.8 U      | 10.7       | 31.5       | 29.2       | 21300      | 0.037 UJ   | 596        | 22         | 15.9       | 5.47 UJ    | 74.9       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE 1/1000t | NEUTRAL. POTENT. 1/1000t | SULFUR ACID BASE POTENT. 1/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE 1/1000t | SULFUR ACID BASE POTENT. 1/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 29-033-TP-1 | 0.1            | 3.12                           | 6.78                     | 3.65                             | 0.1              | <0.01            | <0.01            | 0                                | 6.78                             |
| 29-033-TP-2 | 0.26           | 8.12                           | 0.24                     | -7.9                             | 0.25             | 0.01             | <0.01            | 0.31                             | -0.07                            |
| 29-033-WR-1 | 0.15           | 4.69                           | 0.27                     | -4.4                             | 0.1              | <0.01            | 0.05             | 0                                | 0.27                             |
| 29-033-WR-2 | 0.14           | 4.37                           | 0.41                     | -4                               | 0.14             | <0.01            | <0.01            | 0                                | 0.41                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co  | Cr     | Cu   | Fe       | Hg     | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO <sub>3</sub> /L) | HARDNESS CALC. |
|-------------|--------|------|--------|-----|--------|------|----------|--------|------|--------|--------|--------|------------------------------|----------------|
| 29-033-SW-1 | 1.29 J | 23.4 | 4.59 U | 5 U | 6.24 U | 6.37 | 50.8 JX  | 0.12 U | 4.2  | 10.9 U | 1.22 U | 31.7 U | 8.71 U                       | 39.7           |
| 29-033-SW-2 | 5.61 J | 31.1 | 4.59 U | 5 U | 6.24 U | 12.6 | 79.2 JX  | 0.12 U | 11.3 | 10.9 U | 4.39 J | 31.7 U | 8.71 U                       | 58.1           |
| 29-033-SW-3 | 3.38 J | 16   | 7.37   | 158 | 6.24 U | 2130 | 21200 JX | 0.12 U | 9220 | 29.3   | 3.59 J | 31.7 U | 112                          | 172            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO <sub>3</sub> /NO <sub>2</sub> -N | CYANIDE |
|-------------|------------------------|----------|---------|-------------------------------------|---------|
| 29-033-SW-1 | 72                     | <        | 5       | 13                                  | 0.26    |
| 29-033-SW-2 | 124                    | <        | 5       | 25                                  | 0.43    |
| 29-033-SW-3 | 570                    | <        | 5       | 342                                 | 1.63    |
| 29-033-SW-4 | NR                     | NR       | NR      | NR                                  | 0.76    |

**LEGEND**

SE1 - In Park Creek, 5' upstream of where road crosses creek.  
SE2 - In Park Creek, 30' downstream of spring that flows adjacent to tailings pond 1.  
TP1 - Composite of subsamples TP1AA, 1AB, 1BA, 1CA, 1DA, and 1DB.  
TP2 - Composite of subsamples TP1BB, 1BC, 1CB, 1CC, and 1DC.  
WR1 - Composite of subsamples WR1A and 1B.  
WR2 - Composite of subsamples WR2A and 2B.  
BACKGROUND - From the Strawberry Mine (29-038 -SS-1).  
SS1 - Base of heap leach nearest middle pond. Grab 0-6".  
SS2 - Composite of 3 holes in lysimeter field.  
SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.  
SW3 - Adit discharge at waste dump 2.  
SW4 - Middle pond, Southwest.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Boss Tweed</u>                     | County: <u>Madison</u>                              |
| Legal Description: <u>T 2S R 3W</u>                   | Section(s): <u>SW 1/4, NE 1/4, Sec. 15</u>          |
| Mining District: <u>Pony</u>                          | Mine Type: <u>Hardrock/Au, Ag, Cu, Fe</u>           |
| Latitude: <u>N 45° 39' 50"</u>                        | Primary Drainage: <u>North Willow Creek</u>         |
| Longitude: <u>W 111° 57' 20"</u>                      | USGS Code: <u>10020005</u>                          |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Pony Creek</u>               |
| Quad: <u>Pony</u>                                     | Date Investigated: <u>September 14 and 15, 1993</u> |
| Inspectors: <u>M. Babits, S. Babits, Flammang</u>     | P.A. # <u>29-034</u>                                |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- The volume of tailings associated with this site was estimated to be approximately 65,900 cubic yards. The following elements were elevated at least three times background:  
Cadmium: 2.7 to 9 mg/kg      Copper: 95 to 518 mg/kg  
Mercury: 0.468J to 3.53J mg/kg      Lead: 91.7 to 327 mg/kg  
Zinc: 279 to 1,030 mg/kg
- A sample of leach pad material collected from this site revealed a cyanide concentration of 0.394 mg/kg.
- The volume of waste rock associated with this site was estimated to be approximately 26,520 cubic yards. The following elements were elevated at least three times background:  
Cadmium: 5.6 to 13.3 mg/kg      Copper: 146 to 195 mg/kg  
Mercury: 0.26J to 1.16 mg/kg      Manganese: 2,340 to 2,990 mg/kg  
Lead: 138 to 1,870 mg/kg      Zinc: 373 to 842 mg/kg
- Four discharging adits were identified at the site. One of the discharges was sampled for laboratory analysis. No MCLs were exceeded in the adit discharge; however, acute and chronic aquatic life criteria for zinc were exceeded. The chronic aquatic life criteria for mercury was also exceeded.
- Pony Creek flowed through the center of the site. Surface water and sediment samples were collected upstream and downstream from the site in Pony Creek. No MCLs were exceeded; the chronic aquatic life criteria for lead was exceeded in both the upstream and downstream samples. An observed release to Pony Creek (sediment) was documented for zinc.
- Potential safety hazards observed at the site included five open adits, a collapsing loadout structure, and three highwalls (>25 feet).



**Boss Tweed PA# 29-034**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 09/14/93**

**SOLID MATRIX ANALYSES**

| Metals in soils |        | Results per dry weight basis (mg/kg) |       |      |      |      |       |           |      |      |        |         |      |         |
|-----------------|--------|--------------------------------------|-------|------|------|------|-------|-----------|------|------|--------|---------|------|---------|
| FIELD ID        | As     | Ba                                   | Cd    | Co   | Cr   | Cu   | Fe    | Hg        | Mn   | Ni   | Pb     | Sb      | Zn   | CYANIDE |
| 29-034-SE-1     | 17.7 J | 55.6                                 | 1.3 U | 7.71 | 21.8 | 13.5 | 14700 | 0.0347 UJ | 486  | 12.7 | 9.34 U | 9.01 UJ | 44.7 | NR      |
| 29-034-SE-2     | 8.05 J | 27                                   | 2.2   | 4.72 | 5.5  | 93.6 | 12400 | 0.0877 J  | 619  | 6.21 | 34.4   | 7.39 UJ | 206  | NR      |
| 29-034-TP-1     | 11 J   | 55.7                                 | 2.3   | 5.62 | 28.4 | 95   | 24000 | 0.0853 J  | 1290 | 15.4 | 91.7   | 8 UJ    | 279  | NR      |
| 29-034-TP-2     | 17.3 J | 36                                   | 8.3   | 9.49 | 5.91 | 164  | 24500 | 0.468 J   | 745  | 8.58 | 327    | 8.42 UJ | 1030 | 0.353   |
| 29-034-TP-3     | 8.96 J | 15.8                                 | 5.0   | 6.49 | 7.25 | 354  | 20500 | 0.971 J   | 681  | 6.63 | 148    | 6.86 UJ | 389  | NR      |
| 29-034-TP-4     | 7.31 J | 45.9                                 | 9.0   | 9.88 | 6.24 | 518  | 27600 | 3.53 J    | 1060 | 11   | 326    | 7.29 UJ | 849  | 0.646   |
| 29-034-TP-5     | 4.45 U | 103                                  | 2.7   | 7.05 | 13.4 | 32.6 | 14800 | 0.109 J   | 527  | 9.81 | 31.8   | 5.89 UJ | 593  | NR      |
| 29-034-WR-1     | 20.4 J | 133                                  | 5.6   | 16.3 | 14.3 | 195  | 27900 | 1.16 J    | 2340 | 16.9 | 138    | 4.3 UJ  | 373  | NR      |
| 29-034-WR-2     | 13.6 J | 237                                  | 13.3  | 11.4 | 5.43 | 154  | 31500 | 0.838 J   | 2990 | 11.6 | 139    | 5.26 UJ | 842  | NR      |
| 29-034-WR-3     | 37.9 J | 112                                  | 2.3   | 6.48 | 9.78 | 146  | 29200 | 0.26 J    | 439  | 6.26 | 1870   | 5.49 UJ | 99.8 | NR      |
| 29-034-LP-1     | NR     | NR                                   | NR    | NR   | NR   | NR   | NR    | NR        | NR   | NR   | NR     | NR      | NR   | 0.394   |
| BACKGROUND      | 20.1 J | 168                                  | 0.8 U | 10.7 | 31.5 | 29.2 | 21300 | 0.0367 UJ | 596  | 22   | 15.9   | 5.47 UJ | 74.9 | NR      |

U - Not Detected, J - Estimated Quantity, X - Outlier for Accuracy or Precision, NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE U/1000t | NEUTRAL POTENT. U/1000t | SULFUR ACID BASE POTENT. U/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE U/1000t | SULFUR ACID BASE POTENT. U/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 29-034-TP-1 | 0.23           | 7.19                           | 67.3                    | 60.1                             | 0.05             | 0.12             | 0.06             | 3.75                             | 63.6                             |
| 29-034-TP-2 | 1.11           | 34.7                           | 29.2                    | -5.45                            | 0.2              | 0.84             | 0.07             | 26.2                             | 2.98                             |
| 29-034-TP-3 | 0.92           | 28.7                           | 27.8                    | -0.97                            | 0.33             | 0.48             | 0.11             | 15                               | 12.8                             |
| 29-034-TP-4 | 1.03           | 32.2                           | 34.1                    | 1.96                             | 0.3              | 0.61             | 0.12             | 19.1                             | 15.1                             |
| 29-034-TP-5 | 0.09           | 2.81                           | 7.05                    | 4.23                             | 0.04             | 0.01             | 0.04             | 0.31                             | 6.73                             |
| 29-034-WR-1 | 1.17           | 36.6                           | 64.5                    | 27.9                             | <0.01            | 0.86             | 0.51             | 26.9                             | 37.6                             |
| 29-034-WR-2 | 0.28           | 8.75                           | 39.6                    | 30.9                             | 0.12             | <0.01            | 0.17             | 0                                | 39.6                             |
| 29-034-WR-3 | 0.58           | 18.1                           | 2.05                    | -16.1                            | 0.57             | 0.01             | <0.01            | 0.31                             | 1.74                             |
| 29-034-WR-3 | 0.56           | 17.5                           | 2.45                    | -15                              | 0.55             | 0.01             | <0.01            | 0.31                             | 2.13                             |

**WATER MATRIX ANALYSES**

| Metals in Water |        | Results in ug/L |        |     |        |        |        |        |        |        |      |        |                 |                |
|-----------------|--------|-----------------|--------|-----|--------|--------|--------|--------|--------|--------|------|--------|-----------------|----------------|
| FIELD ID        | As     | Ba              | Cd     | Co  | Cr     | Cu     | Fe     | Hg     | Mn     | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
| 29-034-SW-1     | 7.82   | 15.5            | 4.59 U | 5 U | 6.24 U | 2.33 U | 576    | 0.12 J | 28.1   | 10.9 U | 4.99 | 31.7 U | 8.71 U          | 47.3           |
| 29-034-SW-2     | 1.12 U | 13.7            | 4.59 U | 5 U | 6.24 U | 2.57   | 195    | 0.12 U | 19.3   | 10.9 U | 3.55 | 31.7 U | 8.71 U          | 93.7           |
| 29-034-SW-3     | 4.1    | 3.23            | 4.59 U | 5 U | 6.24 U | 12     | 235    | 0.13 J | 394    | 10.9 U | 1.37 | 31.7 U | 250             | 139            |
| 29-034-SW-4     | 1.41   | 1.1 U           | 4.59 U | 5 U | 6.24 U | 2.33 U | 13.7 U | 0.12 U | 3.76 U | 10.9 U | 1.25 | 31.7 U | 8.71 U          | 0.1            |

U - Not Detected, J - Estimated Quantity, X - Outlier for Accuracy or Precision, NR - Not Requested

**Wet Chemistry**

**Results in mg/l**

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 29-034-SW-1 | 96                     | < 5      | < 5     | 0.1       | NR      |
| 29-034-SW-2 | 160                    | < 5      | 49      | 0.44      | < 0.005 |
| 29-034-SW-3 | 217                    | < 5      | 89      | 0.58      | NR      |
| 29-034-SW-4 | NR                     | NR       | NR      | NR        | < 0.005 |

**LEGEND**

LP1 - Small leach pond by WR2.

TP1 - Composite of subsamples TP1A-A through 1A-F, 1B-A through 1B-C, and 2A

TP2 - Composite of subsamples TP1A-D, 1A-E, 1B-D, and 1B-E.

TP3 - Composite of subsamples TP2A-A, 2A-B, 2A-C, 2B-A, 2B-B and 2B-C.

TP4 - Composite of subsamples TP3B-A, 3B-B, 3A-A, 3A-B, and 3A-C.

TP5 - Composite of subsamples TP3B-C and 3A-D.

WR1 - Composite of subsamples WR1, 2, and 3.

WR2 - Composite of subsamples WR4, 5, 6, 7, and 8.

WR3 - Composite of subsamples WR9A, 9B, and 10.

BACKGROUND - From the Strawberry Mine (29-038-SS-1)

SE1 - 500 feet upgradient from waste rock dump 6 in Pony Co.

SE2 - Downgradient of TP3 prior to confluence with tributary.

SW1 - Same as sample SE1.

SW2 - Same as sample SE2.

SW3 - Adit discharge at WR1.

SW4 - QA/QC Blank.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Strawberry  
Legal Description: T 2S R 3W  
Mining District: Pony  
Latitude: N 45° 39' 50"  
Longitude: W 111° 55' 50"  
Land Status: Private  
Quad: Pony  
Inspectors: M. Babits, S. Babits, Flammang  
Organization: Pioneer Technical Services, Inc.

County: Madison  
Section(s): N 1/2, NE 1/4, Sec. 14  
Mine Type: Hardrock/Au, Ag  
Primary Drainage: North Willow Creek  
USGS Code: 10020005  
Secondary Drainage: Pony Creek  
Date Investigated: September 14, 1993  
P.A. # 29-038

- The volume of tailings associated with this site was estimated to be approximately 13,475 cubic yards. The following elements were elevated at least three times background:  
Copper: 167 to 294 mg/kg      Cadmium: 1.8 mg/kg  
Mercury: 1.17J to 1.94J mg/kg      Lead: 367 to 584 mg/kg  
Zinc: 360 mg/kg
- The volume of waste rock associated with this site was estimated to be approximately 12,820 cubic yards. The following elements were elevated at least three times background:  
Copper: 155 to 275 mg/kg      Cadmium: 1.6 to 2.8 mg/kg  
Mercury: 0.218J to 0.882J mg/kg      Lead: 266 to 1,510 mg/kg  
Zinc: 278 mg/kg
- One discharging adit was identified at the site during the investigation. The MCL for cadmium was exceeded in the adit discharge. Acute and chronic aquatic life criteria were exceeded for cadmium, copper, and zinc.
- Pony Creek was flowing through the center of the site during the investigation. Surface water and sediment samples were collected upstream and downstream from the site in Pony Creek. No MCLs were exceeded; however, the chronic aquatic life criteria for mercury was exceeded in both the upstream and downstream samples.
- Ten potentially hazardous open adits and four open shafts were identified at the site.

**Strawberry PA# 29-038**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 09/14/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 29-038-SE-1 | 11.6 J     | 29.6       | 1.5        | 4.04       | 7.65       | 77.7       | 12700      | 0.113 J    | 555        | 12.1       | 43.7       | 7.8 UJ     | 206        | NR              |
| 29-038-SE-2 | 5.81 J     | 55         | 1.7        | 7.96       | 15.4       | 45.7       | 13200      | 0.063 J    | 470        | 14.1       | 21.9       | 5.95 UJ    | 140        | NR              |
| 29-038-TP-1 | 23.2 J     | 141        | 1.8        | 11.9       | 40.6       | 294        | 21300      | 1.17 J     | 330        | 39.5       | 367        | 7.33 UJ    | 360        | NR              |
| 29-038-TP-2 | 26.1 J     | 139        | 1.0 U      | 2.25       | 9.27       | 167        | 20800      | 1.94 J     | 52         | 4.87       | 584        | 6.71 UJ    | 172        | 1.42            |
| 29-038-WR-1 | 32 J       | 83.3       | 2.8        | 18.8       | 39.7       | 275        | 29500      | 0.218 J    | 478        | 33.4       | 1510       | 7 J        | 278        | NR              |
| 29-038-WR-2 | 40.6 J     | 177        | 1.6        | 12.5       | 36.3       | 155        | 36600      | 0.882 J    | 415        | 36.3       | 266        | 5.01 UJ    | 142        | NR              |
| BACKGROUND  | 20.1 J     | 168        | 0.8 U      | 10.7       | 31.5       | 29.2       | 21300      | 0.037 UJ   | 596        | 22         | 15.9       | 5.47 UJ    | 74.9       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID       | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|----------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 29-038-TP-1    | <0.01          | 0                              | 77.6                     | 77.6                             | <0.01            | <0.01            | 0.01             | 0                                | 77.6                             |
| 29-038-TP-2    | 0.34           | 10.6                           | 0.34                     | -10                              | 0.33             | 0.01             | <0.01            | 0.31                             | 0.03                             |
| 29-038-TP-2DUP | 0.32           | 10                             | 0.39                     | -9.6                             | 0.31             | 0.01             | <0.01            | 0.31                             | 0.08                             |
| 29-038-TP-2    | 0.34           | 10.6                           | 0.34                     | -10                              | 0.33             | 0.01             | <0.01            | 0.31                             | 0.03                             |
| 29-038-WR-1    | 0.07           | 2.19                           | 5.38                     | 3.19                             | 0.05             | 0.01             | 0.01             | 0.31                             | 5.06                             |
| 29-038-WR-2    | 0.45           | 14.1                           | 2.26                     | -12                              | 0.44             | 0.01             | <0.01            | 0.31                             | 1.94                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co   | Cr     | Cu     | Fe    | Hg     | Mn   | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. (mg CaCO3/L) |
|-------------|------|------|--------|------|--------|--------|-------|--------|------|--------|------|--------|-----------------|-----------------------------|
| 29-038-SW-1 | 2.82 | 13.1 | 4.59 U | 5 U  | 6.24 U | 2.33 U | 66.5  | 0.12 U | 4.6  | 10.9 U | 1.35 | 31.7 U | 8.71 U          | 75.5                        |
| 29-038-SW-2 | 3.37 | 16.5 | 4.59 U | 5 U  | 6.24 U | 2.33 U | 268   | 0.23 J | 43   | 10.9 U | 1.64 | 31.7 U | 24              | 87.2                        |
| 29-038-SW-3 | 4.86 | 38.1 | 12.9   | 36.7 | 6.37   | 77.7   | 12000 | 0.16 J | 1750 | 81.4   | 1.61 | 31.7 U | 762             | 276                         |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------|----------|---------|-----------|---------|
| 29-038-SW-1 | 164              | < 5      | 31      | 0.3       | NR      |
| 29-038-SW-2 | 151              | < 5      | 40      | 0.4       | NR      |
| 29-038-SW-3 | 401              | < 5      | 187     | 0.37      | NR      |

**LEGEND**

SE1 - 250 feet upstream of mine access road Pony Creek crossing.  
SE2 - 1200' downstream of mill ruins below last tailings.  
TP1 - Composite of subsamples TP1A-A 1A-B, 2A-A, 2A-B, 2C-A, 2B-A, and 2B-C.  
TP2 - Composite of subsamples TP1A-C, 1A-D, 1A-E, and 2B-C.  
WR1 - Composite of subsamples WR1, 2, 3A, and 3B.  
WR2 - Composite of subsamples WR4A, 4B, 6, 7, 8, and 9.  
BACKGROUND - From the Strawberry Mine (29-038-SS-1).

SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.  
SW3 - Adit discharge at waste rock dump 9.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Emma  
Legal Description: T 3S R 7W  
Mining District: Rochester  
Latitude: N 45° 34' 37"  
Longitude: W 112° 02' 19"  
Land Status: Public  
Quad: Nez Perce Hollow  
Inspectors: Babits, Lasher/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Madison  
Section(s): SE 1/4, SW 1/4, Sec. 6  
Mine Type: Hardrock/Au, Pb, Ag, Zn  
Primary Drainage: Big Hole River  
USGS Code: 10020004  
Secondary Drainage: Nez Perce Creek  
Date Investigated: June 18, 1993  
P.A. # 29-061

- The volume of tailings associated with this site was estimated to be approximately 11,700 cubic yards. The following elements were elevated at least three times background:

|                               |                               |
|-------------------------------|-------------------------------|
| Arsenic: 3,710 to 5,840 mg/kg | Cadmium: 115JX to 495JX mg/kg |
| Copper: 492 to 1,440 mg/kg    | Mercury: 0.199 to 0.5 mg/kg   |
| Lead: 8,990 to 29,500 mg/kg   | Antimony: 95J to 194J mg/kg   |
| Zinc: 7,400 to 46,200 mg/kg   |                               |
- The volume of waste rock associated with this site was estimated to be approximately 15,185 cubic yards. The following elements were elevated at least three times background:

|                                |                                |
|--------------------------------|--------------------------------|
| Arsenic: 9,500 to 11,900 mg/kg | Cadmium: 82.3JX to 206JX mg/kg |
| Copper: 552 to 870 mg/kg       | Mercury: 1.08 to 3.88 mg/kg    |
| Manganese: 2,030 mg/kg         | Lead: 27,500 to 41,200 mg/kg   |
| Antimony: 40J to 100J mg/kg    | Zinc: 9,100 to 9,200 mg/kg     |
- No discharging adits, filled shafts, seeps, or springs were identified at the site during the investigation.
- No surface water was identified on or near the site. The nearest flowing water was approximately one mile away; consequently, no surface water or sediment samples were collected.
- Potentially hazardous mine openings identified at the site included one open shaft and four open adits.



**Emma PA# 29-061**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 06/18/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 29-061-TP-1 | 3710          | 29.9          | 115 JX        | 7.8           | 9             | 492           | 46700         | 0.5           | 727           | 21            | 8990          | 95 J          | 7400          | NR                 |
| 29-061-TP-2 | 5840          | 33.7          | 495 JX        | 16.2          | 7             | 1440          | 59600         | 0.199         | 1370          | 33            | 29500         | 194 J         | 46200         | NR                 |
| 29-061-WR-1 | 2910          | 157           | 72.8 JX       | 17.4          | 20.5          | 160           | 38200         | 1.99          | 1670          | 33            | 6200          | 34 J          | 4490          | NR                 |
| 29-061-WR-2 | 9500          | 30.5          | 82.3 JX       | 10.8          | 5.4           | 552           | 61100         | 1.08          | 943           | 22            | 27500         | 100 J         | 9100          | NR                 |
| 29-061-WR-3 | 11900         | 30            | 206 JX        | 21.7          | 5.5           | 870           | 54600         | 3.88          | 2030          | 23            | 41200         | 40 J          | 9200          | NR                 |
| BACKGROUND  | 56            | 169           | 0.8 JX        | 13.8          | 29.4          | 34.2          | 25300         | 0.014 U       | 462           | 26            | 30            | 4 UJ          | 119           | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|----------------------|---|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 29-061-TP-1 | 1.51                 | 47.2                                    | 6.08                          | -41                                       | 1.01                   | 0.19                   | 0.31                   | 5.94                                      | 0.14                                      |
| 29-061-TP-2 | 5.99                 | 187                                     | 23.3                          | -164                                      | <0.01                  | 4.34                   | 2.44                   | 136                                       | -112                                      |
| 29-061-WR-1 | 0.04                 | 1.25                                    | 40.1                          | 38.9                                      | 0.03                   | <0.01                  | 0.01                   | 0   | 40.1                                      |
| 29-061-WR-2 | 3.41                 | 107                                     | 4.61                          | -102                                      | 1.25                   | 0.78                   | 1.38                   | 24.4                                      | -19.8                                     |
| 29-061-WR-3 | 0.44                 | 13.7                                    | 15.2                          | 1.47                                      | 0.41                   | <0.01                  | 0.05                   | 0   | 15.2                                      |

**LEGEND**

TP1 - Composite of subsamples TP1B-A, 1A-A, and 1A-B.  
TP2 - Composite of subsamples TP1A-C and 1A-D.  
WR1 - Composite of subsamples WR1AA, 1B, and 6.  
WR2 - Composite of subsamples WR2A, 2B, 2C, 4A, and 4B.  
WR3 - Sample of the WR5 subsample.  
BACKGROUND - On top of the hill, upgradient of waste rock dump 6. From the Emma Mine (29-061-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Thistle Mine and Millsite  
Legal Description: T 3S R 7W  
Mining District: Rochester  
Latitude: N 45° 37' 27"  
Longitude: W 112° 29' 28"  
Land Status: Private  
Quad: Twin Bridges  
Inspectors: Tuesday, Babits, Belanger,  
Lasher, Clark/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Madison  
Section(s): SE 1/4, SW 1/4, Sec. 5  
Mine Type: Hardrock/Au, Ag, Pb  
Primary Drainage: Rochester Creek  
USGS Code: 10020004  
Secondary Drainage: Rochester Creek  
Date Investigated: June 15, 1993  
P.A. # 29-073

- The volume of tailings associated with this site was estimated to be approximately 56,950 cubic yards. The following elements were elevated at least three times background:

|                               |                              |
|-------------------------------|------------------------------|
| Arsenic: 2,730 to 6,850 mg/kg | Cadmium: 3.8 to 10.5 mg/kg   |
| Copper: 371 to 887 mg/kg      | Mercury: 0.255 to 3.51 mg/kg |
| Lead: 2,500 to 5,850 mg/kg    | Antimony: 27 to 59 mg/kg     |
- The volume of waste rock associated with this site was estimated to be approximately 6,393 cubic yards. The following elements were elevated at least three times background:

|                              |                            |
|------------------------------|----------------------------|
| Arsenic: 275 mg/kg           | Cadmium: 4.3 to 37.3 mg/kg |
| Mercury: 0.366 to 2.21 mg/kg | Manganese: 1,610 mg/kg     |
| Lead: 309 to 1,720 mg/kg     | Zinc: 1,720 mg/kg          |
- No discharging adits, filled shafts, seeps, or springs were identified at the site.
- Intermittent Rochester Creek was situated adjacent to the tailings at the site. Sediment samples were collected upstream and downstream from the site. Observed releases to Rochester Creek (sediment) were documented for arsenic, cadmium, mercury, and lead.
- Potentially hazardous mine openings identified at the site included four open shafts and six open adits.

**Thistle PA# 29-073**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE:**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID     | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|--------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 29-073-SE-1  | 124           | 83.1          | 0.5           | 4.3           | 21.8          | 83.7          | 12600         | 0.015         | 130           | 11            | 71            | < 3           | 32            | NR                 |
| 29-073-SE-2  | 590           | 49.9          | 1.6           | 4.9           | 14.7          | 162           | 19600         | 0.087         | 169           | 13            | 650           | 6             | 64            | NR                 |
| 29-073-SE-3  | 291           | 52.7          | < 0.6         | 6.9           | 18.1          | 66.7          | 20400         | < 0.024       | 131           | 17            | 204           | < 4           | 43            | NR                 |
| 29-073-TP-1A | 2730          | 39            | 3.8           | 3.9           | 4.5           | 371           | 32300         | 0.255         | 67.4          | 6             | 2500          | 27            | 100           | NR                 |
| 29-073-TP-1B | 6850          | 97.9          | 10.5          | 6             | 18.1          | 887           | 67300         | 3.51          | 122           | 10            | 5850          | 59            | 117           | NR                 |
| 29-073-WR-1  | 13            | 61.3          | 4.3           | 13.7          | 28.4          | 30.8          | 36100         | 0.366         | 738           | 26            | 309           | < 3           | 187           | NR                 |
| 29-073-WR-2  | 275           | 68.5          | 37.3          | 31.8          | 38.3          | 67.7          | 45900         | 2.21          | 1610          | 53            | 1720          | < 4           | 1720          | NR                 |
| BACKGROUND   | 19            | 144           | 0.6           | 14.1          | 47.5          | 32.6          | 26800         | 0.02 J        | 481           | 29            | 30            | < 3 UJ        | 74            | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID     | TOTAL SULFUR<br>% | TOTAL SULFUR ACID BASE<br>t/1000t | NEUTRAL POTENT.<br>t/1000t | SULFUR ACID BASE POTENT.<br>t/1000t | SULFATE SULFUR<br>% | PYRITIC SULFUR<br>% | ORGANIC SULFUR<br>% | PYRITIC SULFUR ACID BASE<br>t/1000t | SULFUR ACID BASE POTENT.<br>t/1000t |
|--------------|-------------------|-----------------------------------|----------------------------|-------------------------------------|---------------------|---------------------|---------------------|-------------------------------------|-------------------------------------|
| 29-073-TP-1A | 1.15              | 35.9                              | -6.7                       | -43                                 | 0.85                | 0.15                | 0.15                | 4.69                                | -11.4                               |
| 29-073-TP-1B | 1.23              | 38.4                              | -2.9                       | -41                                 | 1.16                | 0.01                | 0.06                | 0.31                                | -3.26                               |
| 29-073-WR-1  | 0.1               | 3.12                              | 70.7                       | 67.6                                | <0.01               | 0.02                | 0.1                 | 0.62                                | 70.1                                |
| 29-073-WR-2  | 0.14              | 4.37                              | 74.6                       | 70.2                                | 0.01                | 0.02                | 0.11                | 0.62                                | 74                                  |

**LEGEND**

SE1 - Upstream of tailings in Rochester Creek.  
SE2 - At breach where tailings flow into creek.  
SE3 - Downstream from tailings impoundment in Rochester Creek.  
TP1A - Composite of subsamples TP1C-A, 1C-B, 1C-C, and 1D-A  
TP1B - Composite of subsamples TP1A-A, 1A-C, 1B-A, and 1D-B  
WR1 - Composite of subsamples WR1A and 12.  
WR2 - Composite of subsamples WR1B, 11, 13, 14, and 15.  
BACKGROUND - Above WR15. From the Thistle Mine (29-073-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Watseca</u>                        | County: <u>Madison</u>  |
| Legal Description: T <u>2S</u> R <u>7W</u>            | Section(s): <u>SW 1/4, NW 1/4, Sec. 32; NE 1/4, SE 1/4, SEC. 31</u> |
| Mining District: <u>Rochester</u>                     | Mine Type: <u>Hardrock/Ag, Au, Cu, Zn</u>                           |
| Latitude: <u>N 45° 37' 15"</u>                        | Primary Drainage: <u>Big Hole River</u>                             |
| Longitude: <u>W 112° 30' 15"</u>                      | USGS Code: <u>10020004</u>  |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Rochester Creek</u>                          |
| Quad: <u>Nez Perce Hollow</u>                         | Date Investigated: <u>September 20, 1993</u>                        |
| Inspectors: <u>Bullock, Tuesday, Flammang</u>         | P.A. # <u>29-075</u>  |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- The site was active, apparently operating under a Small Miner Exclusion.
- The Thistle I tailings (PA# 29-073) and waste rock from the Watseca dumps were being reprocessed in a cyanide vat leach operation. The tailings impoundment was lined with geotextile and process water appeared to be recycled. No samples were collected.
- There were no discharging adits on site.
- There was no surface water on site; no surface water samples were collected. The nearest surface water was Rochester Creek, an intermittent drainage approximately 100 feet from the facility. The drainage was dry at the time of this investigation.
- There was one hazardous open shaft on site. Several other shafts have been grouted by the AMRB.





**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |  |
|--|--|
| Mine/Site Name: <u>Smuggler</u>  | County: <u>Madison</u>                             |
| Legal Description: <u>T 4S R 4W</u>  | Section(s): <u>SE 1/4, SW 1/4, SW 1/4, Sec. 13</u> |
| Mining District: <u>Sheridan</u>   | Mine Type: <u>Hardrock/Au, Ag</u>                  |
| Latitude: <u>N 45° 28' 57"</u>   | Primary Drainage: <u>Mill Creek</u>                |
| Longitude: <u>W 112° 02' 18"</u>   | USGS Code: <u>10020003</u>                         |
| Land Status: <u>Public</u>   | Secondary Drainage: <u>Mill Creek</u>              |
| Quad: <u>Copper Mountain</u>   | Date Investigated: <u>June 16, 1993</u>            |
| Inspectors: <u>Tuesday, Babits, Belanger, Lasher, Clark/Pierson</u>                  | P.A. # <u>29-010</u>                               |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |  |

- The volume of tailings associated with this site was estimated to be approximately 3,000 cubic yards. Approximately 80% of the tailings surface was naturally revegetated. The following elements were elevated at least three times background:  
Cadmium: 3.9J mg/kg      Lead: 504 mg/kg  
Mercury: 2.51 mg/kg      Zinc: 435 mg/kg
- The volume of waste rock associated with this site was estimated to be approximately 8,500 cubic yards. The following elements were elevated at least three times background:  
Cadmium: 6.6 mg/kg      Lead: 514 mg/kg  
Mercury: 0.207J mg/kg      Zinc: 1,030 mg/kg
- Four adits were associated with this site; however, only one of the adits (Adit #1) was discharging water. The Adit #1 discharge was very minor (<1 gpm), and eventually seeped into the ground. The discharge did not exceed any MCL/MCLGs; however, the chronic aquatic life criteria for mercury was exceeded.
- Mill Creek was located approximately 200 yards downgradient from the adits and associated waste rock dumps, and approximately 20 yards downgradient from the tailings on the opposite side of the Mill Creek Road. Mill Creek was not sampled during the investigation.
- Adit #4 was open and posed a hazard.

**Smuggler PA# 29-010**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 06/16/93**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 29-010-TP-1 | 36         | 14.8       | 3.9 J      | 14.8       | 30.2       | 58.4       | 25700      | 2.51       | 703        | 41         | 504        | 4 UJ       | 435        | NR              |
| 29-010-WR-1 | 29         | 26.1       | 6.6        | 22.9       | 74.6       | 71.7       | 37100      | 0.207 J    | 1220       | 78         | 514        | 3 UJ       | 1030       | NR              |
| BACKGROUND  | 20         | 96.4       | 1.2 JX     | 20.2       | 42.1       | 35.1       | 18200      | 0.017 U    | 608        | 59         | 25         | 4 UJ       | 61         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 29-010-TP-1 | 0.07           | 2.19                           | 49.2                    | 47                               | 0.01             | 0.02             | 0.04             | 0.62                             | 48.6                             |
| 29-010-WR-1 | 0.31           | 9.68                           | 115                     | 105                              | <0.01            | 0.14             | 0.24             | 4.37                             | 111                              |

**Cation Exchange Capacity**

| FIELD ID    | milliequivalents/100g |
|-------------|-----------------------|
| 29-010-TP-1 | 2.8                   |

**WATER MATRIX ANALYSES**

**Metals in Water**  
**Results in ug/L**

| FIELD ID    | As     | Ba   | Cd     | Co     | Cr  | Cu     | Fe   | Hg   | Mn    | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|--------|--------|-----|--------|------|------|-------|--------|--------|--------|-----------------|----------------|
| 29-010-SW-1 | 1.69 U | 7.13 | 2.55 U | 5.99 U | 5 U | 1.93 J | 46.2 | 0.26 | 2.6 U | 10.5 J | 1.55 U | 18.3 U | 19.6            | 186            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Wet Chemistry**  
**Results in mg/l**

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 29-010-SW-1 | 234                    | < 5.0    | 19      | 0.13      | NR      |

**LEGEND**

TP1 - Composite of the subsamples TP1A and 1B.  
 WR1 - Composite of the subsamples WR1A through 1C, and 3A, and 3B.  
 BACKGROUND - From the Uncle Sam Mine (29-383-SS-1).  
 SW1 - Adit discharge.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Goldschmidt/Steiner  
Legal Description: T 4S R 4W  
Mining District: Sheridan  
Latitude: N 45° 27' 10"  
Longitude: W 112° 02' 40"  
Land Status: Public  
Quad: Copper Mountain  
Inspectors: Babits, Flammang/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Madison  
Section(s): NE 1/4, SW 1/4, Sec. 25  
Mine Type: Hardrock/Au  
Primary Drainage: Ramshorn Creek  
USGS Code: 10020003  
Secondary Drainage: Currant Creek  
Date Investigated: August 25, 1993  
P.A. # 29-078

- No tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 6,000 cubic yards. The following elements were elevated at least three times background:

|                                   |                                |
|-----------------------------------|--------------------------------|
| Arsenic: 164 mg/kg                | Cadmium: 7.79J to 74.9J mg/kg  |
| Copper: 112 mg/kg                 | Mercury: 0.49J to 1.01J mg/kg  |
| Manganese: 2,390J to 8,800J mg/kg | Nickel: 191JX mg/kg            |
| Lead: 403JX to 1,500JX mg/kg      | Antimony: 8.53J to 37.1J mg/kg |
| Zinc: 885J to 8,890J mg/kg        |                                |
- No discharging adits, filled shafts, seeps, or springs were identified at the site during the investigation.
- Currant Creek was flowing through the center of the site during the investigation. Surface water and sediment samples were collected upstream and downstream from the site in Currant Creek. No MCLs were exceeded; however, chronic aquatic life criteria for mercury and lead were exceeded in both the upstream and downstream samples.
- Observed releases to Currant Creek (sediment) were documented for mercury, manganese, nickel, lead, and zinc.
- Eight potentially hazardous open adits were identified at the site.



**Goldschmidt-Steiner PA# 29-078**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/25/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 29-078-SE-1 | 7.52 U     | 129 J      | 1.4 U      | 10.3       | 60.2       | 20         | 15000      | 0.054 U    | 481        | 29.6 J     | 10.3 U     | 9.95 UJ    | 67.6       | NR              |
| 29-078-SE-2 | 14.7       | 535 J      | 1.6        | 46.2       | 82.7       | 55.1       | 25100      | 0.208 J    | 2730       | 101 J      | 80.1       | 6.34 UJ    | 208        | NR              |
| 29-078-WR-1 | 32.9       | 139 J      | 10.2       | 37.2       | 54.1       | 78.8       | 27900      | 0.557 J    | 3350       | 100 J      | 1150       | 6.98 UJ    | 953        | NR              |
| 29-078-WR-2 | 19.7       | 228 J      | 7.79 J     | 30.8       | 72.3 JX    | 57.6       | 35000      | 1.01 J     | 8800 J     | 191 JX     | 403 JX     | 8.53 J     | 885 J      | NR              |
| 29-078-WR-3 | 164        | 41.7 J     | 74.90 J    | 59.9       | 45.4 JX    | 112        | 39700      | 0.49 J     | 2390 J     | 133 JX     | 1500 JX    | 37.1 J     | 8890 J     | NR              |
| BACKGROUND  | 20         | 96.4       | 1.2 JX     | 20.2       | 42.1       | 35.1       | 18200      | 0.017 U    | 608        | 59         | 25         | 4 UJ       | 61         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 29-078-WR-1 | <0.01          | 0                              | 21.4                     | 21.4                             | <0.01            | 0.01             | <0.01            | 0.31                             | 21.1                             |
| 29-078-WR-2 | <0.01          | 0                              | 177                      | 177                              | <0.01            | <0.01            | 0.01             | 0                                | 177                              |
| 29-078-WR-3 | 0.11           | 3.44                           | 50.1                     | 46.7                             | 0.05             | 0.01             | 0.05             | 0.31                             | 49.8                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu     | Fe  | Hg      | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|--------|-------|--------|--------|-----|---------|------|--------|--------|--------|-----------------|----------------|
| 29-078-SW-1 | 0.96 U | 42.8 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 278 | 0.14 JX | 41.4 | 19.1   | 4.53 J | 30.7 U | 10.7 J          | 59.2           |
| 29-078-SW-2 | 0.96 U | 44.1 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 501 | 0.2 JX  | 45   | 12.7 U | 2.86 J | 30.7 U | 17.4 J          | 69.4           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 29-078-SW-1 | 107                    | < 5.0    | < 5     | 0.33      | NR      |
| 29-078-SW-2 | 111                    | < 5.0    | < 5     | 0.31      | NR      |

**LEGEND**

SE1 - 250' upgradient from cabin in Current Creek.  
SE2 - 100' downgradient from waste rock dump 1 in Current Creek.  
WR1 - Composite of subsamples WR1, 9A, 9B, and 9C.  
WR2 - Composite of subsamples WR4, 7, and 3.  
WR3 - Composite of subsamples WR10A, 10B, 10C, and 13.  
BACKGROUND - From Uncle Sam Mine (29-383-SS-1).

SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Red Pine  
Legal Description: T 4S R 4W  
Mining District: Sheridan  
Latitude: N 45° 31' 20"  
Longitude: W 112° 05' 05"  
Land Status: Public  
Quad: Noble Peak  
Inspectors: Babits, Flammang/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Madison  
Section(s): NW 1/4, NW 1/4, Sec. 3  
Mine Type: Hardrock/Au, Cu  
Primary Drainage: Indian Creek  
USGS Code: 10020003  
Secondary Drainage: Unnamed tributary to  
Indian Creek  
Date Investigated: August 25, 1993  
P.A. # 29-079

- The volume of tailings associated with this site was estimated to be approximately 4,450 cubic yards. The following elements were elevated at least three times background:  
Copper: 236 to 298 mg/kg      Mercury: 0.432J to 0.442J mg/kg  
Antimony: 11.8J to 30.4J mg/kg
- The volume of waste rock associated with this site was estimated to be approximately 25,000 cubic yards. The following elements were elevated at least three times background:  
Copper: 408 mg/kg      Mercury: 0.453J mg/kg  
Antimony: 42.7J mg/kg
- One discharging adit was identified at the site during the investigation. No MCLs were exceeded in the adit discharge; however, chronic aquatic life criteria were exceeded for mercury and lead. This discharge eventually flowed into Indian Creek.
- Indian Creek was flowing south of the site during the investigation; however, surface water samples were not collected due to extremely high flow and likely excessive dilution. Indian Creek sediment samples were collected upstream and downstream from the site; metals concentrations were not significantly elevated in the downstream sample.
- One potentially hazardous open adit was identified at the site.

**Red Pine PA# 29-079**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/25/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 29-079-SE-1 | 5.96       | 42.3 J     | 1.04 UJ    | 9.92       | 38.6 JX    | 39.1       | 13600      | 0.039 UJ   | 460 J      | 28 JX      | 7.4 UJX    | 7.14 UJ    | 64.9 J     | NR              |
| 29-079-SE-2 | 9.58       | 51.5 J     | 1.21 UJ    | 10.4       | 44.6 JX    | 43.4       | 14800      | 0.032 UJ   | 931 J      | 34.4 JX    | 8.68 UJX   | 8.38 UJ    | 58.2 J     | <0.334          |
| 29-079-TP-1 | 62.7       | 193 J      | 0.97 UJ    | 17.4       | 26.5 JX    | 236        | 43900      | 0.432 J    | 3150 J     | 48.3 JX    | 27.8 JX    | 11.8 J     | 61.3 J     | NR              |
| 29-079-TP-2 | 68.2       | 125 J      | 0.99 UJ    | 17.9       | 29.9 JX    | 298        | 43200      | 0.442 J    | 2950 J     | 42.1 JX    | 38.1 JX    | 30.4 J     | 74.6 J     | <0.290          |
| 29-079-TP-3 | 5.18 U     | 83.6 J     | 0.99 UJ    | 10.5       | 31.6 JX    | 42.5       | 19000      | 0.032 J    | 1510 J     | 26.3 JX    | 7.09 UJX   | 6.85 UJ    | 40.3 J     | <0.284          |
| 29-079-WR-1 | 64.5       | 39.2 J     | 0.80 UJ    | 19.5       | 12.6 JX    | 408        | 39600      | 0.453 J    | 3420 J     | 35 JX      | 14 JX      | 42.7 J     | 75.4 J     | NR              |
| BACKGROUND  | 26         | 154        | 8.6 JX     | 15.3       | 26.1       | 29.6       | 20200      | 0.021      | 1240       | 43         | 89         | 4 UJ       | 70         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 29-079-TP-1 | 0.7            | 21.9                           | 346                      | 324                              | <0.01            | 0.64             | 0.31             | 20                               | 326                              |
| 29-079-TP-2 | 0.64           | 20                             | 184                      | 164                              | 0.21             | 0.39             | 0.04             | 12.2                             | 172                              |
| 29-079-TP-3 | 0.06           | 1.87                           | 32.6                     | 30.7                             | 0.02             | 0.01             | 0.03             | 0.31                             | 32.2                             |
| 29-079-WR-1 | 3.8            | 119                            | 379                      | 260                              | <0.01            | 2.39             | 3.88             | 74.7                             | 304                              |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co    | Cr     | Cu     | Fe   | Hg      | Mn   | Ni     | Pb     | Sb     | Zn     | HARDNESS CALC. (mg CaCO3/L) |
|-------------|------|------|--------|-------|--------|--------|------|---------|------|--------|--------|--------|--------|-----------------------------|
| 29-079-SW-3 | 1.07 | 5.73 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 43.1 | 0.21 JX | 5.47 | 12.7 U | 2.24 J | 30.7 U | 10.9 J | 50.7                        |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| Field ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 29-079-SW-3 | 90                     | < 5.0    | < 5     | 0.07      | NR      |

**LEGEND**

SE1 - In Indian Creek, 75' up from confluence with adit discharge.

SE2 - In Indian Creek at PPE of tailings pond 3.

TP1 - Composite of subsamples TP1AA through 1AC, 1BA, 2AA through 2AC, and 3A through 3C.

TP2 - Composite of subsamples TP1BB through 1BE.

TP3 - Composite of subsamples TP2AD and 3D.

WR1 - Composite of subsamples WR1A through 1C.

BACKGROUND - From NW SE Sec. 26 (29-476-SS-1).

SW3 - Discharging adit at waste rock dump 1.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Broadgauge</u>                     | County: <u>Madison</u>                       |
| Legal Description: T <u>4S</u> R <u>4W</u>            | Section(s): <u>SE 1/4, SW 1/4, Sec. 17</u>   |
| Mining District: <u>Sheridan</u>                      | Mine Type: <u>Hardrock/Au, Ag</u>            |
| Latitude: <u>N 45° 28' 56"</u>                        | Primary Drainage: <u>Mill Creek</u>          |
| Longitude: <u>W 112° 08' 04"</u>                      | USGS Code: <u>10020003</u>                   |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Spring Park Creek</u> |
| Quad: <u>Sheridan</u>                                 | Date: <u>June 16, 1993</u>                   |
| Inspectors: <u>Tuesday, Belanger, Clark</u>           | P.A. # <u>29-293</u>                         |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no mill tailings observed at this site during the investigation.
- The volume of waste rock associated with the site was estimated to be approximately 2,100 cubic yards (WR-1 was located in an intermittent drainage). The following elements were elevated at least three times background:

|                           |                               |
|---------------------------|-------------------------------|
| Arsenic: 208 to 257 mg/kg | Cadmium: 9.3J mg/kg           |
| Iron: 59,400 mg/kg        | Manganese: 1620 to 1630 mg/kg |
| Nickel: 73 to 109 mg/kg   | Lead: 231 to 2660 mg/kg       |
| Zinc: 1900 mg/kg          |                               |
- There was one adit discharge observed at the site during the investigation. No MCLs or acute or chronic aquatic life criteria were exceeded in the adit discharge sample.
- Three hazardous mine openings (two open shafts and one caved shaft) were observed at the site, two of the openings were surrounded by barbed wire; however, the barbed wire was very loose and did not include any warning signs.



**Broad Gauge PA# 29-293**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 07/16/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 29-293-WR-1 | 208        | 33.6       | 9.3 J      | 19.5       | 65         | 213        | 59400      | 0.344      | 1620       | 73         | 2660       | 4 UJ       | 1900       | NR              |
| 29-293-WR-2 | 257        | 37.3       | 0.6 J      | 26.7       | 58.4       | 63.2       | 31900      | 0.409      | 1630       | 109        | 231        | 3 UJ       | 164        | NR              |
| BACKGROUND  | 16         | 89.4       | 0.8 JX     | 9.4        | 25.1       | 21.6       | 14900      | 1.1        | 366        | 19         | 36         | 4 UJ       | 80         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 29-293-WR-1 | 2.46           | 76.9                           | 135                     | 58.5                             | 1.6              | 0.38             | 0.48             | 11.9                             | 123                              |
| 29-293-WR-2 | 1.53           | 47.8                           | 169                     | 122                              | 1.1              | 0.21             | 0.22             | 6.56                             | 163                              |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co     | Cr  | Cu    | Fe  | Hg   | Mn   | Ni     | Pb   | Sb     | HARDNESS CALC. Zn (mg CaCO3/L) |
|-------------|------|------|--------|--------|-----|-------|-----|------|------|--------|------|--------|--------------------------------|
| 29-293-SW-1 | 8.65 | 10.6 | 2.55 U | 5.99 U | 5 U | 6.9 J | 640 | 0.14 | 77.3 | 8.78 U | 32.9 | 18.3 U | 190 280                        |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD I.D.  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 29-293-SW-1 | 360                    | < 5.0    | 106     | 0.31      | NR      |

**LEGEND**

WR1 - Composite of subsamples WR1A, 1B, and 1C.  
WR2 - Composite of subsamples WR2A, 2B, and 2C.  
BACKGROUND - From the Latest Out Mine (29-354-SS-1).

SW1 - Caved flowing adit.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |  |
|--|--|
| Mine/Site Name: <u>Latest Out</u>  | County: <u>Madison</u>                     |
| Legal Description: <u>T 4S R 4W</u>  | Section(s): <u>SE 1/4, NE 1/4, Sec. 32</u> |
| Mining District: <u>Sheridan</u>   | Mine Type: <u>Hardrock/Unknown</u>         |
| Latitude: <u>N 45° 26' 35"</u>   | Primary Drainage: <u>Ruby River</u>        |
| Longitude: <u>W 112° 06' 53"</u>   | USGS Code: <u>10020003</u>                 |
| Land Status: <u>Public</u>   | Secondary Drainage: <u>Sand Coulee</u>     |
| Quad: <u>Copper Mountain</u>   | Date Investigated: <u>June 17, 1993</u>    |
| Inspectors: <u>Babits, Lasher/Pierson</u>  | P.A. # <u>29-354</u>                       |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |  |

- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 13,871 cubic yards. The following elements were elevated at least three times background:

|                    |                                 |
|--------------------|---------------------------------|
| Arsenic: 68 mg/kg  | Cadmium: 3.3JX to 7JX mg/kg     |
| Cobalt: 31.3 mg/kg | Copper: 166 to 227 mg/kg        |
| Iron: 46,300 mg/kg | Manganese: 1,190 to 1,760 mg/kg |
| Nickel: 83 mg/kg   | Lead: 329 to 671 mg/kg          |
| Zinc: 282 mg/kg    |                                 |
- A groundwater spring, which flowed into a stock watering trough, was identified at the site. No MCLs were exceeded in the spring; however, the chronic aquatic life criteria for mercury was exceeded. The pH measurement in the spring was 7.42.
- An intermittent drainage was located north of the site. The drainage was dry during the investigation; no surface water or sediment samples were collected.
- Potential safety hazards identified at the site included three open shafts and four open adits.

**Latest Out PA# 29-354**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 06/17/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 29-354-WR-1 | 32         | 177        | 3.3 JX     | 24.7       | 15         | 166        | 46300      | 0.015 U    | 1760       | 33         | 671        | 4 UJ       | 282        | NR              |
| 29-354-WR-2 | 68         | 151        | 7 JX       | 31.3       | 49         | 227        | 37800      | 0.014 U    | 1190       | 83         | 329        | 4 J        | 214        | NR              |
| BACKGROUND  | 16         | 89.4       | 0.8 JX     | 9.4        | 25.1       | 21.6       | 14900      | 1.1        | 366        | 19         | 36         | 4 UJ       | 80         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID       | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|----------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 29-354-WR-1    | <0.01          | 0                              | 20.7                    | 20.7                             | <0.01            | <0.01            | 0.02             | 0                                | 20.7                             |
| 29-354-WR-1DUP | 0.01           | 0.31                           | 19.8                    | 19.5                             | <0.01            | <0.01            | 0.02             | 0                                | 19.8                             |
| 29-354-WR-2    | 0.26           | 8.12                           | 31.9                    | 23.8                             | 0.24             | <0.01            | 0.03             | 0                                | 31.9                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co     | Cr  | Cu     | Fe   | Hg   | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|--------|--------|-----|--------|------|------|------|--------|--------|--------|-----------------|----------------|
| 29-354-GW-1 | 1.69 U | 49.1 | 2.55 U | 5.99 U | 5 U | 1.53 J | 14.6 | 0.25 | 17.9 | 8.78 U | 1.55 U | 18.3 U | 6 U             | 178            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 29-354-GW-1 | 279                    | < 5.0    | 33      | 0.68      | NR      |

**LEGEND**

WR1 - Composite of subsamples WR3, 4, and 5.

WR2 - Composite of subsamples WR1, 2, 6, 7, 8, and 9.

WR2DUP - Duplicate of sample 29-354-WR-2.

BACKGROUND - 300 feet upgradient of waste rock dump 8.

From the Latest Out (29-354-SS-1).

GW1 - Spring below waste rock dump 2 in pipe.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |   |
|--|---|
| Mine/Site Name: <u>Uncle Sam</u>   | County: <u>Madison</u>                            |
| Legal Description: <u>T 4S R 3W</u>  | Section(s): <u>NE 1/4, Sec. 17</u>                |
| Mining District: <u>Sheridan</u>   | Mine Type: <u>Hardrock/Au, Ag, Pb</u>             |
| Latitude: <u>N 45° 29' 35"</u>   | Primary Drainage: <u>Mill Creek</u>               |
| Longitude: <u>W 111° 59' 15"</u>   | USGS Code: <u>10020003</u>                        |
| Land Status: <u>Public</u>   | Secondary Drainage: <u>Middle Fork Mill Creek</u> |
| Quad: <u>Ramshorn Mountain</u>   | Date Investigated: <u>June 16, 1993</u>           |
| Inspectors: <u>Babits, Lasher/Pierson</u>  | P.A. # <u>29-383</u>                              |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |   |

- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 18,600 cubic yards. The following elements were elevated at least three times background:

|                    |                      |
|--------------------|----------------------|
| Arsenic: 258 mg/kg | Cadmium: 4.9JX mg/kg |
| Copper: 261 mg/kg  | Mercury: 0.473 mg/kg |
| Lead: 443 mg/kg    | Zinc: 494 mg/kg      |
- Two discharging adits were identified at the site. MCLs for cadmium and nickel were exceeded in both discharges; additionally, the MCL for antimony was exceeded in the lower adit (SW-3). Acute and chronic aquatic life criteria were exceeded for cadmium, copper, and zinc in both discharges, and chronic aquatic life criteria were exceeded for iron, mercury, and lead in both discharges. Adit discharge pH measurements were 3.29 and 4.95 for SW-3 and SW-4, respectively.
- Middle Fork Mill Creek was flowing adjacent to the site on the south side. Surface water and sediment samples were collected upstream and downstream from the site in Middle Fork Mill Creek. No MCLs were exceeded; however, acute and chronic aquatic life criteria were exceeded for zinc in the downstream sample. The chronic aquatic life criteria for copper was exceeded in the downstream sample. An observed release to Middle Fork Mill Creek was documented for zinc. Additionally, observed releases to Middle Fork Mill Creek (sediment) were documented for lead and zinc.
- No hazardous mine openings were identified at the site; however, a case of explosives, saturated with water, was located at the site.



**Uncle Sam PA# 29-383**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 06/16/93**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 29-383-SE-1 | 23         | 97.7       | 1 UJX      | 21.9       | 71.8       | 42.3       | 23000      | 0.03 U     | 579        | 62         | 20         | 7 UJ       | 65         | NR              |
| 29-383-SE-2 | 62         | 28.4       | 2.5 JX     | 17.2       | 42.4       | 86.9       | 28700      | 0.021      | 456        | 55         | 68         | 4 UJ       | 216        | NR              |
| 29-383-WR-1 | 258        | 13.8       | 4.9 JX     | 28.2       | 10.8       | 261        | 50200      | 0.473      | 470        | 77         | 443        | 4 UJ       | 494        | NR              |
| 29-383-WR-2 | 3 U        | 63.5       | 0.8 JX     | 16         | 62.4       | 54.6       | 18100      | 0.013 U    | 226        | 49         | 15         | 3 UJ       | 39         | NR              |
| BACKGROUND  | 20         | 96.4       | 1.2 JX     | 20.2       | 42.1       | 35.1       | 18200      | 0.017 U    | 608        | 59         | 25         | 4 UJ       | 61         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID       | TOTAL SULFUR % | TOTAL SULFUR ACID BASE $\mu$ /1000t | NEUTRAL. POTENT. $\mu$ /1000t | SULFUR ACID BASE POTENT. $\mu$ /1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE $\mu$ /1000t | SULFUR ACID BASE POTENT. $\mu$ /1000t |
|----------------|----------------|-------------------------------------|-------------------------------|---------------------------------------|------------------|------------------|------------------|---------------------------------------|---------------------------------------|
| 29-383-WR-1    | 1.82           | 56.9                                | 40.5                          | -16                                   | 0.16             | 1.01             | 0.65             | 31.6                                  | 8.91                                  |
| 29-383-WR-2DUP | 0.01           | 0.31                                | 9.59                          | 9.28                                  | <0.01            | <0.01            | 0.01             | 0                                     | 9.59                                  |
| 29-383-WR-2    | 0.03           | 0.94                                | 10.1                          | 9.21                                  | 0.01             | <0.01            | 0.02             | 0                                     | 10.1                                  |

**WATER MATRIX ANALYSES**

**Metals in Water**  
**Results in ug/L**

| FIELD ID    | As     | Ba   | Cd     | Co     | Cr   | Cu     | Fe   | Hg   | Mn    | Ni     | Pb     | Sb     | Zn (mg CaCO <sub>3</sub> /L) | HARDNESS CALC. |
|-------------|--------|------|--------|--------|------|--------|------|------|-------|--------|--------|--------|------------------------------|----------------|
| 29-383-SW-1 | 1.69 U | 6.57 | 2.55 U | 5.99 U | 5 U  | 1.35 U | 26.8 | 0.19 | 2.6 U | 8.78 U | 1.55 U | 18.3 U | 6 U                          | 16.2           |
| 29-383-SW-2 | 1.69 U | 7.17 | 2.55 U | 5.99 U | 5 U  | 3.23 J | 277  | 0.2  | 19.9  | 8.78 U | 1.55 U | 18.3 U | 37.3                         | 18.2           |
| 29-383-SW-3 | 4.18   | 3.8  | 19.3   | 34.5   | 5 U  | 114 J  | 2550 | 0.18 | 869   | 104 J  | 16.9   | 19.2   | 1240                         | 220            |
| 29-383-SW-5 | 7.34   | 7.7  | 22.8   | 41.9   | 6.97 | 69.9 J | 5490 | 0.26 | 1290  | 212 J  | 18.8   | 18.3 U | 2090                         | 163            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Wet Chemistry**  
**Results in mg/l**

| FIELD I.D.  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO <sub>3</sub> /NO <sub>2</sub> -N | CYANIDE |
|-------------|------------------------|----------|---------|-------------------------------------|---------|
| 29-383-SW-1 | 56                     | < 5.0    | 6       | 0.09                                | NR      |
| 29-383-SW-2 | 58                     | < 5.0    | 8       | 0.06                                | NR      |
| 29-383-SW-3 | 306                    | < 5.0    | 163     | 0.15                                | NR      |
| 29-383-SW-5 | 284                    | < 5.0    | 181     | < 0.05                              | NR      |

**LEGEND**

SE1 - Upgradient on Middle Fork Mill Creek; 100' above upper adit dump 1.  
 SE2 - Downgradient of upper adit discharge into Mill Creek. (PPE for upper adit discharge).  
 WR1 - Composite of subsamples WR1A, 1B, 1C, and 1D.  
 WR2 - Sample of the subsample WR2.  
 WR2DUP - Duplicate of sample 29-383-WR-2.  
 BACKGROUND - From the Uncle Sam Mine (29-383-SB-1).

SW1 - Same as SE1.  
 SW2 - Same as SE2.  
 SW3 - Lower adit discharge in Middle Fork Mill Creek above confluence with Mill Creek.  
 SW5 - Upper adit discharge.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Lakeshore  
Legal Description: T 3S R 4W  
Mining District: Sheridan  
Latitude: N 45° 35' 00"  
Longitude: W 112° 07' 00"  
Land Status: Private/Public  
Quad: Noble Peak  
Inspectors: Babits, Lasher/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Madison  
Section(s): SE 1/4, SE 1/4, Sec. 8  
Mine Type: Hardrock/Au  
Primary Drainage: Wisconsin Creek  
USGS Code: 10020003  
Secondary Drainage: Crystal Lake  
Date Investigated: July 21, 1993  
P.A. # 29-436

- There were approximately 13,300 cubic yards of uncovered tailings at the site. The following were elevated at least 3 times background:  
Copper: 587 mg/kg  
Mercury: 5.18J mg/kg  
Lead: 1,330 mg/kg  
Zinc: 511 mg/kg
- There were approximately 38,300 cubic yards of uncovered waste rock. The following were elevated at least 3 times background:  
Cadmium: 47.6 mg/kg  
Copper: 379 mg/kg  
Lead: 768 to 3,500 mg/kg  
Zinc: 302 to 8,720 mg/kg
- There were two discharging adits at the site (SW-3 and SW-4) and one (SW-3) entered Crystal Lake. Measured pH's were 7.97 (SW-3) and 7.92 (SW-4). Neither discharge exceeded MCLs or MCLGs or any chronic or acute fresh water aquatic life criteria.
- Crystal Lake contained tailings and was adjacent to waste rock and Wisconsin Creek was adjacent to waste rock. Observed releases of cadmium, copper, mercury, lead, and zinc were documented in downstream sediments; and an observed release of copper was documented in downstream surface water. No MCLs or MCLGs were exceeded, but chronic and acute fresh water aquatic life criteria were exceeded for copper in downstream surface water.
- There were three open adits at the site.

**Lakeshore PA# 29-436**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/21/93**

**SOLID MATRIX ANALYSES**

| Metals in soils<br>Results per dry weight basis   |                |  |                                    |  |                  |                  |                  |  |  |            |            |            |            |                 |
|---|----------------|--|------------------------------------|--|------------------|------------------|------------------|--|--|------------|------------|------------|------------|-----------------|
| FIELD ID  | As (mg/Kg)     | Ba (mg/Kg)                               | Cd (mg/Kg)                         | Co (mg/Kg)                                 | Cr (mg/Kg)       | Cu (mg/Kg)       | Fe (mg/Kg)       | Hg (mg/Kg)                                 | Mn (mg/Kg)                                 | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 29-436-SE-1   | 11.9           | 37.5                                     | 1.2                                | 9.41                                       | 23.7             | 20.3             | 12300            | 0.064 J                                    | 271 J                                      | 17.6       | 14.6       | 6.66 U     | 41         | NR              |
| 29-436-SE-2   | 102            | 223                                      | 9.7                                | 31   | 54.9             | 191              | 32500            | 0.825 J                                    | 3910 J                                     | 42         | 322        | 18.9 U     | 686        | 0.783 U         |
| 29-436-TP-1   | 186            | 28.8                                     | 1.4                                | 4.8  | 8.36             | 587              | 38200            | 5.18 J                                     | 121 J                                      | 9.06       | 1330       | 16.4       | 511        | 0.326 U         |
| 29-436-WR-1   | 15.1           | 89.3                                     | 0.6                                | 17.2                                       | 38.8             | 87               | 28600            | 0.701 J                                    | 601 J                                      | 40.6       | 47.8       | 4.63 U     | 108        | NR              |
| 29-436-WR-2   | 307            | 24.6                                     | 47.6                               | 5.36                                       | 7.94             | 379              | 62300            | 0.27 J                                     | 72.2 J                                     | 7.62       | 3500       | 25.6       | 8720       | NR              |
| 29-436-WR-3   | 41.3           | 45.9                                     | 1.3                                | 12.9                                       | 26               | 101              | 23100            | 0.127 J                                    | 423 J                                      | 19.8       | 768        | 6.22 U     | 302        | NR              |
| BACKGROUND  | 103            | 94                                       | 1.8                                | 19.8                                       | 100              | 57.4             | 34300            | 1.23 J                                     | 606 J                                      | 61.4       | 31.9       | 16.9       | 70.6       | NR              |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                |  |                                    |  |                  |                  |                  |  |  |            |            |            |            |                 |
| Acid/Base Accounting  |                |  |                                    |  |                  |                  |                  |  |  |            |            |            |            |                 |
| FIELD ID  | TOTAL SULFUR % | TOTAL SULFUR ACID BASE $\frac{1}{1000t}$ | NEUTRAL. POTENT. $\frac{1}{1000t}$ | SULFUR ACID BASE POTENT. $\frac{1}{1000t}$ | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE $\frac{1}{1000t}$ | SULFUR ACID BASE POTENT. $\frac{1}{1000t}$ |            |            |            |            |                 |
| 29-436-WR-1   | 0.64           | 20                                       | 36.9                               | 16.9                                       | 0.05             | 0.3              | 0.29             | 9.37                                       | 37.6                                       |            |            |            |            |                 |
| 29-436-WR-2   | 1.87           | 58.4                                     | -1.6                               | -60  | 1.58             | 0.08             | 0.21             | 2.5  | -4.07                                      |            |            |            |            |                 |
| 29-436-WR-3   | 0.04           | 1.25                                     | 3.12                               | 1.87                                       | 0.02             | <0.01            | 0.02             | 0  | 3.12                                       |            |            |            |            |                 |
| 29-436-WR-3DUP  | 0.04           | 1.25                                     | 3.28                               | 2.03                                       | 0.02             | <0.01            | 0.02             | 0  | 3.28                                       |            |            |            |            |                 |

**WATER MATRIX ANALYSES**

| Metals in Water<br>Results in ug/L  |                        |          |         |                                     |         |        |        |         |        |        |        |        |        | HARDNESS CALC. Zn (mg CaCO <sub>3</sub> /L) |
|---|------------------------|----------|---------|-------------------------------------|---------|--------|--------|---------|--------|--------|--------|--------|--------|---|
| FIELD ID  | As                     | Ba       | Cd      | Co                                  | Cr      | Cu     | Fe     | Hg      | Mn     | Ni     | Pb     | Sb     |        |   |
| 29-436-SW-1   | 1.69 U                 | 8.63     | 2.57 U  | 9.7 U                               | 6.83 U  | 1.55 U | 14.8   | 0.038 U | 4.08 U | 12.7 U | 1.55 U | 30.7 U | 7.57 U | 25.5  |
| 29-436-SW-2   | 1.38                   | 11.5 JX  | 2.57 U  | 9.7 U                               | 10.5 J  | 9.23 J | 72.9 J | 0.038 U | 4.08 U | 12.9   | 0.72 U | 30.7 U | 10.4 J | 32.8  |
| 29-436-SW-3   | 2.29                   | 18.4 JX  | 2.57 U  | 9.7 U                               | 7.07 J  | 6 J    | 72.8 J | 0.038 U | 4.13   | 12.7 U | 0.72 U | 30.7 U | 29.2 J | 96.6  |
| 29-436-SW-4   | 1.32                   | 2.01 UX  | 2.57 U  | 9.7 U                               | 6.83 U  | 1.55 U | 17 J   | 0.038 U | 4.08 U | 12.7 U | 0.72 U | 30.7 U | 7.57 U | 0.1   |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                        |          |         |                                     |         |        |        |         |        |        |        |        |        |   |
| Wet Chemistry<br>Results in mg/l  |                        |          |         |                                     |         |        |        |         |        |        |        |        |        |   |
| FIELD I.D.  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO <sub>3</sub> /NO <sub>2</sub> -N | CYANIDE |        |        |         |        |        |        |        |        |   |
| 29-436-SW-1   | 93                     | < 5.0    | 9       | 0.08                                | < 0.01  |        |        |         |        |        |        |        |        |   |
| 29-436-SW-2   | 72                     | < 5.0    | 11      | < 0.05                              | < 0.01  |        |        |         |        |        |        |        |        |   |
| 29-436-SW-3   | 150                    | < 5.0    | 38      | 0.1                                 | NR      |        |        |         |        |        |        |        |        |   |
| 29-436-SW-4   | NR                     | NR       | NR      | NR                                  | < 0.01  |        |        |         |        |        |        |        |        |   |

**LEGEND**

SE1 - 20 feet upstream from waste rock dump 2.

SE2 - 20 feet downstream from culvert at South end of Crystal Lake.

TP1 - Composite of subsamples TP1A, 1B, and 1C.

WR1 - Composite of subsamples WR1A, 1B, 1C, 1E, and 3.

WR2 - Sample of the subsample WR1F.

WR3 - Sample of the subsample WR2.

WR3DUP - Duplicate of the sample 29-436-WR-3.

BACKGROUND - Above waste rock dump 3.

From the Lakeshore Mine (29-436-S9-1).

SW1 - Same as SE1.

SW2 - Same as SE2.

SW3 - Southern adit discharge at waste rock dump 1.

SW4 - Northern adit discharge at waste rock dump 1.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |   |
|--|---|
| Mine/Site Name: <u>Buckeye</u>   | County: <u>Madison</u>                        |
| Legal Description: <u>T 4S R 4W</u>  | Section(s): <u>SE 1/4, SE 1/4, Sec. 19</u>    |
| Mining District: <u>Sheridan</u>   | Mine Type: <u>Hardrock/Pb, Zn, Au, Ag, Cu</u> |
| Latitude: <u>N 45° 28' 15"</u>   | Primary Drainage: <u>Ruby River</u>           |
| Longitude: <u>W 12° 07' 47"</u>  | USGS Code: <u>10020003</u>                    |
| Land Status: <u>Private</u>  | Secondary Drainage: <u>Mill Creek</u>         |
| Quad: <u>Sheridan</u>  | Date Investigated: <u>August 27, 1993</u>     |
| Inspectors: <u>Babits, Flammang/Pierson</u>  | P.A. # <u>29-451</u>                          |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |   |

- There were no mill tailings associated with this site.
- There were approximately 4,350 cubic yards of mostly uncovered waste rock at the site. The following were elevated at least 3 times background:
  - Arsenic: 129J to 359J mg/kg
  - Cadmium: 17.2J to 24.9J mg/kg
  - Cobalt: 47.4 mg/kg
  - Copper: 159 to 1,460 mg/kg
  - Iron: 45,100 to 58,700 mg/kg
  - Manganese: 3,050 mg/kg
  - Nickel: 127 mg/kg
  - Lead: 427 to 10,300 mg/kg
  - Antimony: 12.4 mg/kg
  - Zinc: 3,060 to 4,130 mg/kg
- There were no discharging adits at the site.
- Mill Creek was adjacent to waste rock and observed releases of copper, lead and zinc were documented in downstream sediments. No surface water samples were collected because of high flow in Mill Creek.
- Barrels with unknown contents were at the site. There were no hazardous openings; however, there were numerous hazardous structures.



**Buckeye PA# 29-451**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/27/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 29-451-SE-1 | 4.27 U        | 31.1          | 0.82 U        | 4.57          | 21.5          | 12.5          | 8020          | 0.09 J        | 158           | 16.9          | 6.39          | 5.64 U        | 22.2          | <0.309             |
| 29-451-SE-2 | 8.47 J        | 71            | 1.11 U        | 12.1          | 62            | 40.9          | 15300         | 0.174 J       | 192           | 40.2          | 55.5          | 7.68 U        | 131           | <0.387             |
| 29-451-TP-1 | 90.3 J        | 101           | 5.65 J        | 12.8          | 24.6          | 205           | 25200         | 0.517 J       | 978           | 35.5          | 677           | 6.62 U        | 674           | <0.280             |
| 29-451-TP-2 | 58.1 J        | 121           | 7.91 J        | 15.1          | 18.8          | 135           | 25700         | 1.1 J         | 1060          | 28            | 714           | 6.87 U        | 823           | <0.283             |
| 29-451-WR-1 | 359 J         | 98.4          | 24.90 J       | 47.4          | 41.4          | 159           | 58700         | 0.907 J       | 3050          | 127           | 427           | 6.8 U         | 4130          | NR                 |
| 29-451-WR-2 | 129 J         | 21.4          | 17.20 J       | 6.1           | 3.92          | 1460          | 45100         | 2.64 J        | 336           | 7.06          | 10300         | 12.4          | 3060          | NR                 |
| BACKGROUND  | 16            | 89.4          | 0.8 JX        | 9.4           | 25.1          | 21.6          | 14900         | 1.1           | 366           | 19            | 36            | 4 UJ          | 80            | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID       | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL.<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|----------------|----------------------|---|--------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 29-451-TP-1    | 0.73                 | 22.8                                    | 113                            | 90.6                                      | 0.32                   | 0.28                   | 0.13                   | 8.75                                      | 105                                       |
| 29-451-TP-2    | 0.8                  | 25                                      | 124                            | 99  | 0.19                   | 0.54                   | 0.07                   | 16.9                                      | 107                                       |
| 29-451-WR-1DUP | 1.75                 | 54.7                                    | 117                            | 62.6                                      | 0.31                   | 0.86                   | 0.58                   | 26.9                                      | 90.4                                      |
| 29-451-WR-1    | 1.72                 | 53.7                                    | 119                            | 65.6                                      | 0.28                   | 0.86                   | 0.58                   | 26.9                                      | 92.5                                      |
| 29-451-WR-2    | 6.22                 | 194                                     | 15.3                           | -179                                      | 2.66                   | 1.48                   | 2.08                   | 46.2                                      | -30.9                                     |

**LEGEND**

SE1 - 500 feet upgradient of waste rock dump 5 in Mill Creek.  
SE2 - Downgradient (@ PPE) of waste rock dump 5 in Mill Creek.  
TP1 - Composite of subsamples TPA-A, 1A-B, 2A-A, 2A-B, 3A-A.  
TP2 - Composite of subsamples TP1A-C through 1A-F, TP2A-C,  
and TP3A-B through 3A-E.  
WR1 - Composite of subsamples WR1, 2, and 3.  
WR1DUP - Duplicate of sample 29-451-WR-1.  
WR2 - Composite of subsamples WR4A, 4B, 5A, and 5B.  
BACKGROUND - From Latest Out (29-354-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Pedro</u>                          | County: <u>Madison</u>                               |
| Legal Description: <u>T 4S R 3W</u>                   | Section(s): <u>SW 1/4, SW 1/4, Sec. 17</u>           |
| Mining District: <u>Sheridan</u>                      | Mine Type: <u>Hardrock/Pb, Ag, Au</u>                |
| Latitude: <u>N 45° 29' 48"</u>                        | Primary Drainage: <u>Ramshorn Creek</u>              |
| Longitude: <u>W 112° 00' 10"</u>                      | USGS Code: <u>10020003</u>                           |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>North Fork Ramshorn Creek</u> |
| Quad: <u>Copper Mountain</u>                          | Date: <u>June 18, 1993</u>                           |
| Inspectors: <u>Tuesday, Belanger, Clark</u>           | P.A. # <u>29-455</u>                                 |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- "Tailings piles" identified at this site appeared more like waste rock; and there was no evidence of a mill at the site.
- The volume of waste rock associated with this site, including the possible tailings piles, was estimated to be approximately 6,450 cubic yards. The following elements were elevated at least three times background:

|                     |                               |
|---------------------|-------------------------------|
| Chromium: 257 mg/kg | Mercury: 0.145 to 0.913 mg/kg |
| Nickel: 296 mg/kg   | Lead: 78 mg/kg                |
- There were no adit discharges, filled shafts, seeps or springs observed at the site.
- There was no flowing surface water observed in the vicinity of this site during the investigation.
- Two hazardous openings were observed at the site including: an open adit located on the north side of the ridge, and a shaft which had caved into an unstable pit located adjacent to the access road.

**Pedro PA# 29-455**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 06/18/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 29-455-WR-1 | 5             | 150           | 0.4 U         | 11.8          | 31.3          | 34.5          | 23700         | 0.913         | 717           | 26            | 12            | 3 UJ          | 65            | NR                 |
| 29-455-WR-2 | 12            | 111           | 0.5 U         | 11.3          | 39.7          | 33.5          | 22500         | 0.145         | 561           | 31            | 72            | 4 UJ          | 82            | NR                 |
| 29-455-WR-3 | 26            | 160           | 0.5 U         | 28.6          | 257           | 53.9          | 30500         | 0.418         | 1090          | 296           | 78            | 4 UJ          | 112           | NR                 |
| BACKGROUND  | 20            | 96.4          | 1.2 JX        | 20.2          | 42.1          | 35.1          | 18200         | 0.017 U       | 608           | 59            | 25            | 4 UJ          | 61            | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR ACID BASE<br>t/1000t | NEUTRAL. POTENT.<br>t/1000t | SULFUR ACID BASE<br>POTENT. t/1000t | SULFATE SULFUR<br>% | PYRITIC SULFUR<br>% | ORGANIC SULFUR<br>% | PYRITIC SULFUR ACID BASE<br>t/1000t | SULFUR ACID BASE<br>POTENT. t/1000t |
|-------------|-------------------|-----------------------------------|-----------------------------|-------------------------------------|---------------------|---------------------|---------------------|-------------------------------------|-------------------------------------|
| 29-455-WR-1 | 0.01              | 0.31                              | 18.2                        | 17.8                                | <0.01               | <0.01               | 0.01                | 0                                   | 18.2                                |
| 29-455-WR-2 | <0.01             | 0                                 | 6.41                        | 6.41                                | <0.01               | <0.01               | <0.01               | 0                                   | 6.41                                |
| 29-455-WR-3 | 0.03              | 0.94                              | 10.5                        | 9.59                                | 0.01                | <0.01               | 0.02                | 0                                   | 10.5                                |

**LEGEND**

WR1 - Composite of subsamples WR1A through 1C.  
WR2 - Composite of subsamples WR2, 3A, and 3B.  
WR3 - Composite of subsamples WR4A and 4B.  
BACKGROUND - From Uncle Sam Mine (29-383-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>SE SW S26</u>                      | County: <u>Madison</u>  |
| Legal Description: T <u>3S</u> R <u>5W</u>            | Section(s): <u>SE 1/4, SW 1/4, Sec. 26; NW 1/4, NW 1/4, Sec. 35</u> |
| Mining District: <u>Sheridan</u>                      | Mine Type: <u>Hardrock/Unknown</u>                                  |
| Latitude: <u>N 45° 32' 30"</u>                        | Primary Drainage: <u>Ruby River</u>                                 |
| Longitude: <u>W 112° 11' 20"</u>                      | USGS Code: <u>10020003</u>  |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Wet Georgia Gulch</u>                        |
| Quad: <u>Old Baldy Mountain</u>                       | Date: <u>June 17, 1993</u>  |
| Inspectors: <u>Tuesday, Belanger, Clark</u>           | P.A. # <u>29-474</u>  |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no mill tailings observed at this site during the investigation.
- There were over 17 waste rock dumps located at the site with the total volume of waste rock estimated to be approximately 14,580 cubic yards. The following elements were elevated at least three times background:

|                            |                              |
|----------------------------|------------------------------|
| Arsenic: 726 to 4650 mg/kg | Cadmium: 52.4J to 57J mg/kg  |
| Copper: 133 to 650 mg/kg   | Mercury: 0.544 to 2.92 mg/kg |
| Nickel: 136 to 142 mg/kg   | Lead: 4360 to 14,400 mg/kg   |
| Antimony: 12J mg/kg        | Zinc: 2300 to 8210 mg/kg     |
- There were no adit discharges, filled shafts, seeps, or springs observed at the site during the investigation; consequently, no groundwater or surface water samples were collected.
- Adits #3, #4B, and #5 were open and potentially hazardous.



**SE SW Section 26 PA# 29-474**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 06/16/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 29-474-WR-1 | 726           | 156           | 15.8 J        | 19.8          | 63.7          | 205           | 24000         | 2.23          | 2590          | 136           | 14400         | 7 J           | 2300          | NR                 |
| 29-474-WR-2 | 1930          | 220           | 0.5 U         | 37.1          | 67            | 133           | 42600         | 2.92          | 1110          | 142           | 185           | 9 J           | 164           | NR                 |
| 29-474-WR-3 | 2450          | 249           | 57 J          | 21.8          | 58.6          | 650           | 47100         | 0.587         | 3550          | 83            | 4360          | 13 J          | 8210          | NR                 |
| 29-474-WR-4 | 4650          | 168           | 52.4 J        | 18.2          | 20.2          | 509           | 57400         | 0.544         | 2670          | 41            | 5670          | 10 J          | 7660          | NR                 |
| BACKGROUND  | 26            | 154           | 8.6 JX        | 15.3          | 26.1          | 29.6          | 20200         | 0.021         | 1240          | 43            | 89            | 4 UJ          | 70            | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL.<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|--------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 29-474-WR-1 | 0.03              | 0.94                                 | 75.5                           | 74.6                                      | 0.01                   | <0.01                  | 0.02                   | 0   | 75.5                                      |
| 29-474-WR-2 | <0.01             | 0                                    | 61.6                           | 61.6                                      | <0.01                  | <0.01                  | 0.01                   | 0   | 61.6                                      |
| 29-474-WR-3 | 0.14              | 4.37                                 | 36.3                           | 31.9                                      | 0.12                   | <0.01                  | 0.03                   | 0   | 36.3                                      |
| 29-474-WR-4 | 0.51              | 15.9                                 | 24.8                           | 8.9                                       | 0.46                   | 0.02                   | 0.03                   | 0.62                                      | 24.2                                      |

**LEGEND**

WR1 - Composite of subsamples WR1 through 6E.  
WR2 - Composite of subsamples WR7 through 9.  
WR3 - Composite of subsamples WR10, 11, and 13.  
WR4 - Composite of subsamples WR14 through 17.  
BACKGROUND - From NW SE Sec.26 (29-476-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: NW SE S26  
Legal Description: T 3S R 5W  
Mining District: Sheridan  
Latitude: N 45° 32' 50"  
Longitude: W 112° 10' 42"  
Land Status: Public  
Quad: Old Baldy Mountain  
Inspectors: Babits, Tuesday, Belanger, Clark,  
Lasher/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Madison  
Section(s): NW 1/4, SE 1/4, Sec. 26  
Mine Type: Hardrock/Au  
Primary Drainage: Ruby River  
USGS Code: 10020003  
Secondary Drainage: Wet Georgia Gulch  
Date Investigated: June 17, 1993  
P.A. # 29-476

- There were no mill tailings associated with this site.
- There was approximately 5,900 cubic yards of mostly uncovered waste rock at the site. The following were elevated at least 3 times background:  
Arsenic: 169 to 832 mg/kg  
Chromium: 238 mg/kg  
Copper: 98.1 to 187 mg/kg  
Mercury: 0.091 to 0.477 mg/kg  
Nickel: 231 mg/kg  
Lead: 504 to 3,790 mg/kg  
Zinc: 2,240 to 2,250 mg/kg
- There were no discharging adits at the site.
- There was waste rock material in the drainage of intermittent Wet Georgia Gulch. There were no surface water samples collected and there were no observed releases documented.
- There were two open adits at the site.

**NW SE Section 26 PA# 29-476**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 06/17/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 29-476-SE-3 | 14         | 83.9       | 0.6 UJX    | 10.4       | 65.1       | 15.5       | 16000      | 0.02 U     | 140        | 55         | 31         | 4 UJ       | 84         | NR              |
| 29-476-SE-4 | 20         | 145        | 1 JX       | 15.1       | 83.5       | 22.1       | 25700      | 0.017 U    | 473        | 62         | 66         | 4 UJ       | 112        | NR              |
| 29-476-WR-1 | 169        | 262        | 16 JX      | 19.5       | 52.8       | 48.7       | 35400      | 0.334      | 2260       | 79         | 504        | 4 UJ       | 2240       | NR              |
| 29-476-WR-2 | 832        | 417        | 19.6 JX    | 30.2       | 238        | 187        | 44000      | 0.091      | 3670       | 231        | 3790       | 4 UJ       | 2250       | NR              |
| 29-476-WR-3 | 27         | 139        | 1.5 JX     | 33         | 21.4       | 98.1       | 21000      | 0.477      | 855        | 43         | 2930       | 3 UJ       | 201        | NR              |
| BACKGROUND  | 26         | 154        | 8.6 JX     | 15.3       | 26.1       | 29.6       | 20200      | 0.021      | 1240       | 43         | 89         | 4 UJ       | 70         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 29-476-WR-1 | 0.25           | 7.81                           | 96.4                    | 88.6                             | 0.01             | 0.07             | 0.17             | 2.19                             | 94.2                             |
| 29-476-WR-2 | 0.53           | 16.6                           | 73                      | 56.4                             | 0.11             | 0.14             | 0.28             | 4.37                             | 68.6                             |
| 29-476-WR-3 | 0.03           | 0.94                           | 27.6                    | 26.7                             | 0.02             | <0.01            | 0.02             | 0                                | 27.6                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co     | Cr  | Cu     | Fe   | Hg   | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|--------|--------|-----|--------|------|------|------|--------|--------|--------|-----------------|----------------|
| 29-476-SW-3 | 1.69 U | 75.7 | 2.55 U | 5.99 U | 5 U | 3.43 J | 94.8 | 0.15 | 3.97 | 12.7 J | 1.55 U | 18.3 U | 6 U             | 191            |
| 29-476-SW-4 | 1.95   | 75.2 | 6.07   | 5.99 U | 5 U | 1.35 U | 309  | 0.15 | 6.57 | 8.78 U | 1.55 U | 18.3 U | 6 U             | 182            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 29-476-SW-3 | 222                    | < 5.0    | 9       | 0.23      | NR      |
| 29-476-SW-4 | 207                    | < 5.0    | 9       | 0.25      | NR      |

**LEGEND**

SE3 - Wet Georgia Gulch at confluence from Argenta.  
 SE4 - Downstream from ores and workings.  
 WR1 - Composite of subsamples WR1, 2, and 3.  
 WR2 - Composite of subsamples WR4 and 5.  
 WR3 - Composite of subsamples WR6, 7, and 8.  
 BACKGROUND - From NW SE S26 (29-476-SS-1).

SW3 - Same as SE3.  
 SW4 - Same as SE4.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Broadway/Victoria</u>              | County: <u>Madison</u>                       |
| Legal Description: <u>T 2S R 6W</u>                   | Section(s): <u>NW 1/4, Sec. 2</u>            |
| Mining District: <u>Silver Star</u>                   | Mine Type: <u>Hardrock/Au, Ag, Pb, Cu</u>    |
| Latitude: <u>N 45° 41' 55"</u>                        | Primary Drainage: <u>Jefferson River</u>     |
| Longitude: <u>W 112° 18' 45"</u>                      | USGS Code: <u>10020005</u>                   |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Tom Benton Gulch</u>  |
| Quad: <u>Silver Star</u>                              | Date Investigated: <u>September 17, 1993</u> |
| Inspectors: <u>M. Babits, S. Babits, Flammang</u>     | P.A. # <u>29-179</u>                         |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- The volume of tailings associated with this site was estimated to be approximately 132,000 cubic yards. The concentration of cyanide measured in the tailings ranged from 1.9 to 6.15 mg/kg. The following elements were elevated at least three times background:

|                                  |                                |
|----------------------------------|--------------------------------|
| Arsenic: 223J to 387J mg/kg      | Cadmium: 17J to 78J mg/kg      |
| Cobalt: 21.1 mg/kg               | Copper: 547 to 4,010 mg/kg     |
| Iron: 60,200JX to 89,000JX mg/kg | Mercury: 0.264J to 2.39J mg/kg |
| Manganese: 3,240 to 9,620 mg/kg  | Lead: 1,380 to 3,760 mg/kg     |
| Antimony: 51.7J mg/kg            | Zinc: 3,550J to 32,300 mg/kg   |
- The volume of waste rock associated with this site was estimated to be approximately 34,575 cubic yards. The following elements were elevated at least three times background:

|                                |                            |
|--------------------------------|----------------------------|
| Arsenic: 218J mg/kg            | Cadmium: 48 mg/kg          |
| Cobalt: 26.5 mg/kg             | Copper: 716 to 3,290 mg/kg |
| Mercury: 0.694J to 1.56J mg/kg | Manganese: 4,690 mg/kg     |
| Lead: 4,020 mg/kg              | Zinc: 7,450 mg/kg          |
- No discharging adits, filled shafts, seeps, or springs were identified at the site.
- No surface water was observed on or near the site. The nearest water was located approximately 1.5 miles away; consequently, no surface water or sediment samples were collected.
- Potential safety hazards identified at the site included four open adits and one open shaft.



**Broadway/Victoria PA# 29-179**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 09/17/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 29-179-TP-1 | 74.1 J        | 234 J         | 17 J          | 7.16          | 10.9 J        | 547           | 38100 JX      | 0.147 J       | 9620          | 21.5          | 1740          | 11.9 J        | 5230 J        | NR                 |
| 29-179-TP-2 | 61.4 J        | 23.3 J        | 11 J          | 10.4          | 9.34 J        | 4010          | 89000 JX      | 0.306 J       | 2290          | 12.7          | 622           | 7 UJ          | 1660 J        | NR                 |
| 29-179-TP-3 | 223 J         | 0.237 U       | 22 J          | 3.54          | 5.99 J        | 300           | 60200 JX      | 0.264 J       | 8040          | 16.1          | 1380          | 7.15 J        | 3550 J        | NR                 |
| 29-179-TP-4 | 68.2 J        | 98.5          | 78            | 21.1          | 28.7          | 2540          | 50400         | 2.39 J        | 3240          | 34.9          | 1870          | 51.7 J        | 32300         | 1.9                |
| 29-179-TP-5 | 387 J         | 28.1 J        | 37 J          | 6.93          | 12 J          | 599           | 60800 JX      | 0.58 J        | 4830          | 25.1          | 3760          | 18 J          | 7230 J        | 6.15               |
| 29-179-WR-1 | 218 J         | 62.1          | 48            | 9.45          | 16.9          | 716           | 29900         | 0.694 J       | 2260          | 17.2          | 4020          | 16.6 J        | 7450          | NR                 |
| 29-179-WR-2 | 8.82 J        | 47.4 J        | 3 J           | 26.5          | 4.88 J        | 3290          | 42500 JX      | 1.56 J        | 4690          | 11            | 18.5          | 5.97 UJ       | 330 J         | NR                 |
| BACKGROUND  | 48.3 J        | 93.9          | 5             | 6.35          | 17.7          | 109           | 19100         | 0.087 J       | 1040          | 15.1          | 227           | 6.39 J        | 676           | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL.<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|--------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 29-179-TP-1 | 0.06              | 1.87                                 | 2.17                           | 215                                       | 0.04                   | <0.01                  | 0.05                   | 0   | 217                                       |
| 29-179-TP-2 | 6.08              | 190                                  | 23.5                           | -166                                      | <0.01                  | 3.91                   | 2.28                   | 122                                       | -98.6                                     |
| 29-179-TP-3 | 7.16              | 224                                  | 237                            | 13  | <0.01                  | 5.71                   | 2.2                    | 178                                       | 58.3                                      |
| 29-179-TP-3 | 7.14              | 223                                  | 237                            | 13.5                                      | <0.01                  | 5.68                   | 2.21                   | 177                                       | 59.2                                      |
| 29-179-TP-4 | 2.01              | 62.8                                 | 111                            | 47.8                                      | 0.84                   | 0.43                   | 0.74                   | 13.4                                      | 97.2                                      |
| 29-179-TP-5 | 5.19              | 162                                  | 190                            | 27.5                                      | <0.01                  | 6.42                   | 1.73                   | 201                                       | -10.8                                     |
| 29-179-WR-1 | 0.99              | 30.9                                 | 189                            | 158                                       | 0.74                   | <0.01                  | 0.32                   | 0   | 189                                       |
| 29-179-WR-2 | 0.06              | 1.87                                 | 135                            | 133                                       | 0.05                   | <0.01                  | 0.01                   | 0   | 135                                       |

**LEGEND**

TP1 - Composite of subsamples TP1A-A, 1A-B, 1A-C, 1B-A, and 1B-B.  
TP2 - Composite of subsamples TP3A-A through 3A-D, and 3B-A  
TP3 - Composite of subsamples TP2A-A and 2B-A.  
TP4 - Grab from flotation tanks in mill building.  
TP5 - Composite of subsamples TP2A-B, 2A-C, 2B-B, 2B-C, and 2B-D.  
WR1 - Composite of subsamples WR1, 2A, 2B, and 2C.  
WR2 - Sample of the WR6 subsample.  
BACKGROUND - From the Broadway/Victoria (29-179-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |  |
|--|--|
| Mine/Site Name: <u>Mammoth</u>   | County: <u>Madison</u>                     |
| Legal Description: T <u>2S</u> R <u>3W</u>   | Section(s): <u>NW 1/4, NW 1/4, Sec. 18</u> |
| Mining District: <u>South Boulder</u>  | Mine Type: <u>Hardrock/Au, Ag, Cu</u>      |
| Latitude: <u>N 45° 40' 00"</u>   | Primary Drainage: <u>Missouri River</u>    |
| Longitude: <u>W 112° 00' 40"</u>   | USGS Code: <u>10020006</u>                 |
| Land Status: <u>Private/Public</u>   | Secondary Drainage: <u>Boulder River</u>   |
| Quad: <u>Manhead Mountain</u>  | Date Investigated: <u>July 19, 1993</u>    |
| Inspectors: <u>Babits, Lasher/Pierson</u>  | P.A. # <u>29-008</u>                       |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |  |

- The volume of tailings associated with this site was estimated to be approximately 47,950 cubic yards. The following elements were elevated at least three times background:

|                           |                            |
|---------------------------|----------------------------|
| Arsenic: 676 to 704 mg/kg | Cadmium: 4.9J mg/kg        |
| Cobalt: 26.2 mg/kg        | Copper: 220 to 1,860 mg/kg |
| Mercury: 0.851 mg/kg      | Lead: 90 mg/kg             |
| Zinc: 293 mg/kg           |                            |
- The volume of waste rock associate with this site was estimated to be approximately 29,350 cubic yards. The following elements were elevated at least three times background:

|                           |                          |
|---------------------------|--------------------------|
| Arsenic: 223 to 339 mg/kg | Copper: 225 to 401 mg/kg |
| Mercury: 1.09 mg/kg       | Lead: 87 mg/kg           |
- One discharging adit was identified at the site. The discharge seeped into waste rock prior to reaching surface water. A sample of this discharge had a pH of 7.45. No MCLs were exceeded in the adit discharge; however, acute and chronic aquatic life criteria were exceeded for copper. The pH measurement in the adit discharge was 7.45.
- An unnamed tributary flowed through the site and discharged into the South Boulder River. Observed releases to the South Boulder River (sediment) were documented for arsenic and copper
- Potential safety hazards identified at the site included one open shaft and two open adits.

**Mammoth Mine PA# 29-008**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/19/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 29-008-SE-1 | 5 U        | 67.2       | 1.4 J      | 5.5        | 12.1       | 15         | 9800       | 0.259      | 274        | 12         | 12         | 6 U        | 28         | NR              |
| 29-008-SE-2 | 7 U        | 31.3       | 1.8 J      | 12.4       | 28         | 64.4       | 10300      | 0.287      | 377        | 33         | 16         | 8 U        | 107        | NR              |
| 29-082-SE-3 | 103 J      | 131 J      | 1.7        | 19.6 JX    | 39.2 JX    | 285 J      | 27200 J    | 0.594      | 723 J      | 39 J       | 33         | 8 UJ       | 214 JX     | NR              |
| 29-008-TP-1 | 676        | 249        | 2.2 J      | 2 U        | 1.9        | 220        | 26900      | 0.372      | 20.6       | 3 U        | 54         | 6 U        | 50         | NR              |
| 29-008-TP-2 | 704        | 279        | 4.9 J      | 26.2       | 8          | 1860       | 44200      | 0.851      | 398        | 24         | 90         | 8 U        | 293        | NR              |
| 29-008-WR-1 | 223        | 88.3       | 3.5 J      | 12.6       | 16.7       | 401        | 38300      | 1.09       | 358        | 20         | 60         | 5 U        | 75         | NR              |
| 29-008-WR-2 | 339        | 143        | 2.4 J      | 7          | 9.6        | 225        | 30800      | 0.474      | 140        | 13         | 87         | 6 U        | 66         | NR              |
| BACKGROUND  | 28         | 174        | 1.5 J      | 11         | 24.3       | 28.6       | 15900      | 0.219      | 1000       | 18         | 23         | 6 U        | 47         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 29-008-TP-1 | 0.15           | 4.69                           | -0.7                    | -5.4                             | 0.13             | 0.02             | <0.01            | 0.62                             | -1.31                            |
| 29-008-TP-2 | 1.64           | 51.2                           | 6.66                    | -45                              | 0.07             | 1.36             | 0.21             | 42.5                             | -35.8                            |
| 29-008-WR-1 | 0.41           | 12.8                           | 12.1                    | -0.7                             | 0.25             | 0.05             | 0.11             | 1.56                             | 10.5                             |
| 29-008-WR-2 | 0.71           | 22.2                           | 1.31                    | -21                              | 0.51             | 0.06             | 0.14             | 1.87                             | -0.57                            |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu     | Fe   | Hg      | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. Zn (mg CaCO3/L) |
|-------------|--------|------|--------|-------|--------|--------|------|---------|--------|--------|--------|--------|-----------------|--------------------------------|
| 29-008-SW-1 | 1.69 U | 37.9 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 34.6 | 0.038 U | 4.08 U | 12.7 U | 1.55 U | 30.7 U | 7.57 U          | 44                             |
| 29-082-SW-1 | 26.5   | 18.8 | 4.77 J | 9.7 U | 6.83 U | 305    | 2740 | 0.039   | 333    | 16.4   | 1.85   | 30.7 U | 129             | 83.1                           |
| 29-008-SW-3 | 6.07   | 33.4 | 2.57 U | 9.7 U | 6.83 U | 173    | 420  | 0.038 U | 28.7   | 12.7 U | 1.55 U | 30.7 U | 24.9            | 48.9                           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD I.D.  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 29-008-SW-1 | 127                    | <        | 5.0     | 0.08      | NR      |
| 29-082-SW-1 | 153                    |          | 5.3     | 0.11      | NR      |
| 29-008-SW-3 | 141                    | <        | 5.0     | 0.14      | NR      |

**LEGEND**

SE1 - Upgradient in unnamed tributary.

SE2 - In Boulder Creek above confluence of unnamed tributary with adit discharge.

29-082-SE3 - Downgradient of site on South Boulder River.

TP1 - Composite of subsamples TP1A-A and 1B.

TP2 - Composite of subsamples TP1A-B, 1A-C, 1A-D, and 1A-E.

WR1 - Composite of subsamples WR1, 2A, 2B, 3A, 3B, and 3C.

WR2 - Composite of subsamples WR4A, 5A, 5B, and 6.

BACKGROUND - From Mammoth Mine (29-008-SS-1).

SW1 - Same as sample SE1.

29-082-SW1 - At PPE of adit discharge and unnamed tributary to S. Boulder River.

SW3 - Adit discharge at Level 1.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Mammoth Tailings  
Legal Description: T 2S R 3W  
Mining District: South Boulder  
Latitude: N 45° 40' 14"  
Longitude: W 112° 00' 48"  
Land Status: Private/Public  
Quad: Manhead Mountain  
Inspectors: Tuesday, Belanger, Clark  
Organization: Pioneer Technical Services, Inc.

County: Madison  
Section(s): Sec. 7 and Sec. 18  
Mine Type: Hardrock/Au, Ag, Cu  
Primary Drainage: Jefferson River  
USGS Code: 10020005  
Secondary Drainage: South Boulder River  
Date Investigated: July 19, 1993  
P.A. # 29-082

- The volume of tailings associated with this site was estimated to be approximately 405,500 cubic yards. Evidence of tailings eroding along the bank of the South Boulder River was observed at the time of the investigation. The following elements were elevated at least three times background:  
Arsenic: 289J to 651J mg/kg  
Lead: 105 mg/kg  
Copper: 434J to 1160J mg/kg  
Zinc: 224JX mg/kg
- The volume of waste rock associated with this site was estimated to be approximately 1000 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 244J mg/kg  
Mercury: 1.2 mg/kg
- There was one adit discharge observed at the site during the investigation. No MCLs/MCLGs were exceeded in the adit discharge sample; however, the acute aquatic life criteria for copper and zinc were exceeded, as well as the chronic aquatic life criteria for copper and zinc. No MCLs/MCLGs were exceeded in a surface water sample collected in the unnamed tributary to the South Boulder River; however, chronic aquatic life criteria for iron, copper and zinc were exceeded, and acute aquatic life criteria for cadmium, copper and zinc were exceeded. No MCLs/MCLGs were exceeded in a groundwater sample collected from a monitoring well located in the northwest section of the site; however, the chronic aquatic life criteria for iron and cadmium were exceeded in the sample.
- Observed releases to the South Boulder River (sediment) were documented for arsenic and copper which were attributable to the site.
- Potential safety hazards observed during the investigation included an open adit and an unstable highwall where tailings were excavated for reprocessing. The chemical building located at the south end of the site contained barrels of sodium sulfide, sodium hypochlorite, caustic soda, sodium cyanide residue, and bags of lime.



**Mammoth Tailings PA# 29-082**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 07/19/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 29-082-SE-1 | 898 J      | 114 J      | 2.2        | 101 JX     | 24.8 JX    | 1010 J     | 55900 J    | 0.388      | 2930 J     | 49 J       | 35         | 7 UJ       | 275 JX     | NR              |
| 29-008-SE-2 | 7 U        | 31.3       | 1.8 J      | 12.4       | 28         | 64.4       | 10300      | 0.287      | 377        | 33         | 16         | 8 U        | 107        | NR              |
| 29-082-SE-3 | 103 J      | 131 J      | 1.7        | 19.6 JX    | 39.2 JX    | 285 J      | 27200 J    | 0.594      | 723 J      | 39 J       | 33         | 8 UJ       | 214 JX     | NR              |
| 29-082-TP-1 | 289 J      | 224 J      | 0.7        | 9.8 JX     | 7.4 JX     | 434 J      | 38300 J    | 0.368      | 530 J      | 11 J       | 22         | 7 UJ       | 94 JX      | 0.279 U         |
| 29-082-TP-2 | 651 J      | 263 J      | 1.9        | 32.2 JX    | 5.2 JX     | 1160 J     | 43200 J    | 0.398      | 441 J      | 26 J       | 23         | 6 UJ       | 224 JX     | 0.308 U         |
| 29-082-TP-3 | 515 J      | 143 J      | 1.1        | 6.6 JX     | 4.2 JX     | 648 J      | 28000 J    | 0.276      | 173 J      | 9 J        | 105        | 7 UJ       | 106 JX     | 0.292 U         |
| 29-082-WR-1 | 244 J      | 137 J      | 0.9        | 5.6 JX     | 3.9 JX     | 63.7 J     | 23000 J    | 1.2        | 223 J      | 9 J        | 19         | 5 UJ       | 74 JX      | NR              |
| BACKGROUND  | 28         | 174        | 1.5 J      | 11         | 24.3       | 28.6       | 15900      | 0.219      | 1000       | 18         | 23         | 6 U        | 47 JX      | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE $\frac{1}{1000t}$ | NEUTRAL. POTENT. $\frac{1}{1000t}$ | SULFUR ACID BASE POTENT. $\frac{1}{1000t}$ | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE $\frac{1}{1000t}$ | SULFUR ACID BASE POTENT. $\frac{1}{1000t}$ |
|-------------|----------------|--|------------------------------------|--|------------------|------------------|------------------|--|--|
| 29-082-TP-1 | 1.91           | 59.7                                     | -5                                 | -65  | 0.91             | 0.85             | 0.15             | 26.6                                       | -31.5                                      |
| 29-082-TP-2 | 0.4            | 12.5                                     | 16                                 | 3.52                                       | 0.15             | 0.2              | 0.05             | 6.25                                       | 9.77                                       |
| 29-082-TP-3 | 0.08           | 2.5                                      | 22.7                               | 20.2                                       | <0.01            | 0.16             | 0.06             | 5  | 17.7                                       |
| 29-082-WR-1 | 0.31           | 9.68                                     | 11.7                               | 1.97                                       | 0.22             | 0.04             | 0.05             | 1.25                                       | 10.4                                       |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co    | Cr     | Cu     | Fe   | Hg      | Mn  | Ni   | Pb   | Sb     | Zn (mg CaCO <sub>3</sub> /L) | HARDNESS CALC. (mg CaCO <sub>3</sub> /L) |
|-------------|------|------|--------|-------|--------|--------|------|---------|-----|------|------|--------|------------------------------|--|
| 29-082-GW-1 | 24.5 | 19   | 2.83 J | 9.9   | 6.83 U | 306    | 2710 | 0.038 U | 347 | 19.3 | 2.27 | 30.7 U | 136                          | 86.3                                     |
| 29-082-GW-2 | 1.79 | 31.5 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 1640 | 0.038 U | 205 | 13.3 | 1.83 | 30.7 U | 17.9                         | 127                                      |
| 29-082-SW-1 | 26.5 | 18.8 | 4.77 J | 9.7 U | 6.83 U | 305    | 2740 | 0.039   | 333 | 16.4 | 1.85 | 30.7 U | 129                          | 83.1                                     |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Wet Chemistry**  
Results in mg/l

| FIELD I.D.  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO <sub>3</sub> /NO <sub>2</sub> -N | CYANIDE |
|-------------|------------------------|----------|---------|-------------------------------------|---------|
| 29-082-GW-1 | 140                    | 6.3      | 74      | 0.17                                | NR      |
| 29-082-GW-2 | 196                    | 5.8      | 95      | < 0.05                              | < 0.01  |
| 29-082-SW-1 | 153                    | 5.3      | 75      | 0.11                                | NR      |

**LEGEND**

SE1 - At PPE of adit discharge and S. Boulder River, in the tributary.

GW1 - Flowing adit.

SE2 - Upgradient sediment sample in the S. Boulder River.

GW2 - Monitor well, Northwest corner.

SE3 - Downgradient of site on S. Boulder River.

SW1 - Same as sample SE1.

TP1 - Composite of subsamples TP1A-1 through 1A-3, 1B-1 through 1B-3, 1C-1 through 1C-3.

TP3 - Composite of subsamples TP2A-1 through 2A-3, 2B-1, and 2B-2.

WR1 - Sample of the WR1A subsample.

BACKGROUND - From the Mammoth Mine (29-008-S3-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |   |
|--|---|
| Mine/Site Name: <u>B &amp; H</u>   | County: <u>Madison</u>                    |
| Legal Description: <u>T 3S R 4W</u>  | Section(s): <u>NE 1/4, NE 1/4, Sec. 7</u> |
| Mining District: <u>Tidal Wave</u>   | Mine Type: <u>Hardrock/Au, Ag, Pb, Cu</u> |
| Latitude: <u>N 45° 35' 40"</u>   | Primary Drainage: <u>Currant Creek</u>    |
| Longitude: <u>W 112° 07' 45"</u>   | USGS Code: <u>10020005</u>                |
| Land Status: <u>Private/Public</u>   | Secondary Drainage: <u>Bear Gulch</u>     |
| Quad: <u>Old Baldy Mountain</u>  | Date Investigated: <u>July 23, 1993</u>   |
| Inspectors: <u>Babits, Lasher/Pierson</u>  | P.A. # <u>29-083</u>                      |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |   |

- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 42,000 cubic yards. The following elements were elevated at least three times background:

|                              |                            |
|------------------------------|----------------------------|
| Arsenic: 113 mg/kg           | Cadmium: 3.8 to 4.2 mg/kg  |
| Cobalt: 42.4J mg/kg          | Chromium: 108 to 158 mg/kg |
| Copper: 215J to 2,930J mg/kg | Iron: 80,100 mg/kg         |
| Mercury: 1.47J mg/kg         | Nickel: 196J mg/kg         |
| Lead: 68J to 81J mg/kg       | Zinc: 422J mg/kg           |
- Two discharging adits were identified at the site during the investigation. One of the discharges eventually entered Bear Gulch; this discharge was sampled for laboratory analysis. No MCLs or acute or chronic aquatic life criteria were exceeded in the adit discharge.
- Bear Gulch was flowing adjacent to the site on the north side during the investigation. Surface water and sediment samples were collected upstream and downstream from the site in Bear Gulch. No MCLs or acute or chronic aquatic life criteria were exceeded in Bear Gulch, and no observed releases were documented.
- No hazardous mine openings were identified at the site.

**B&H PA# 29-083**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/23/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 29-083-SE-1 | 35         | 142 J      | 5.6        | 18.4 J     | 116        | 261 J      | 31800      | 0.461 J    | 927        | 70 J       | 679 J      | 18 U       | 403 J      | NR              |
| 29-083-SE-2 | 80         | 143 J      | 4.1        | 16.5 J     | 52.9       | 232 J      | 35900      | 0.108 J    | 3390       | 58 J       | 132 J      | 7 U        | 436 J      | NR              |
| 29-083-WR-1 | 51         | 289 J      | 4.2        | 17.3 J     | 108        | 215 J      | 28200      | 1.47 J     | 764        | 52 J       | 81 J       | 5 U        | 422 J      | NR              |
| 29-083-WR-2 | 113        | 154 J      | 3.8        | 42.4 J     | 158        | 2930 J     | 80100      | 0.093 J    | 2040       | 196 J      | 68 J       | 6 U        | 121 J      | NR              |
| BACKGROUND  | 103        | 94         | 1.8        | 19.8       | 100        | 57.4       | 34300      | 1.23 J     | 606 J      | 61.4       | 31.9       | 16.9       | 70.6 JX    | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 29-083-WR-1 | 0.47           | 14.7                           | 9.52                    | -5.2                             | 0.17             | 0.12             | 0.18             | 3.75                             | 5.77                             |
| 29-083-WR-2 | 2.6            | 81.2                           | 61.7                    | -20                              | <0.01            | 1.38             | 1.33             | 43.1                             | 18.6                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba      | Cd     | Co    | Cr     | Cu     | Fe     | Hg      | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|---------|--------|-------|--------|--------|--------|---------|--------|--------|--------|--------|-----------------|----------------|
| 29-083-SW-1 | 2.4    | 24.2 JX | 4.2 J  | 9.7 U | 8.87 J | 2.63 J | 48.6 J | 0.038 U | 4.08 U | 12.7 U | 0.95 J | 30.7 U | 7.57 U          | 55.4           |
| 29-083-SW-2 | 1.18 U | 20.8 JX | 2.57 U | 9.7 U | 7.57 J | 2.37 J | 117 J  | 0.038 U | 28.1   | 12.7 U | 0.72 U | 30.7 U | 10 J            | 95.8           |
| 29-083-SW-3 | 3.76   | 13.3 JX | 2.57 U | 9.7 U | 9 J    | 2.63 J | 308 J  | 0.038 U | 103    | 12.7 U | 0.72 U | 30.7 U | 13.6 J          | 192            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 29-083-SW-1 | 97                     | < 5.0    | 34      | < 0.05    | NR      |
| 29-083-SW-2 | 154                    | < 5.0    | 50      | < 0.05    | NR      |
| 29-083-SW-3 | 274                    | < 5.0    | 81      | < 0.05    | NR      |

**LEGEND**

SE1 - 200' upgradient from discharging adit in unnamed tributary.  
SE2 - 60' downgradient of waste rock dump 1 in unnamed tributary.  
WR1 - Composite of subsamples WR1A, 1B, and 1C.  
WR2 - Composite of subsamples WR2A, 2B, 3A, and 3B.  
BACKGROUND - From Lakeshore (29-436-SS-1).

SW1 - Same as SE1.  
SW2 - Same as SE2.  
SW3 - Discharging adit at lower site.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Dry Gulch (South)</u>              | County: <u>Madison</u>                            |
| Legal Description: <u>T 3S R 5W</u>                   | Section(s): <u>W 1/2, Sec. 15; E 1/2, Sec. 16</u> |
| Mining District: <u>Tidal Wave</u>                    | Mine Type: <u>Hardrock/Au, Ag, Pb</u>             |
| Latitude: <u>N 45° 34' 40"</u>                        | Primary Drainage: <u>Jefferson River</u>          |
| Longitude: <u>W 112° 12' 50"</u>                      | USGS Code: <u>10020005</u>                        |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Dry Gulch/Spring Creek</u> |
| Quad: <u>Old Baldy Mountain</u>                       | Date Investigated: <u>July 20, 1993</u>           |
| Inspectors: <u>Tuesday, Belanger, Clark</u>           | P.A. # <u>29-282</u>                              |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be approximately 16,930 cubic yards. The waste rock was separated into 23 dumps. The following elements were elevated at least three times background:

|                           |                        |
|---------------------------|------------------------|
| Arsenic: 93 to 145 mg/kg  | Cadmium: 5.4 mg/kg     |
| Chromium: 71.6JX mg/kg    | Mercury: 1.01 mg/kg    |
| Nickel: 65J to 104J mg/kg | Lead: 469 to 942 mg/kg |
| Zinc: 652JX mg/kg         |                        |
- There were no adit discharges, filled shafts, seeps or springs associated with this site.
- The Dry Gulch stream bed extended through the site from east to west. Sediment samples were collected upstream and downstream from the site in Dry Gulch. No observed releases were documented. None of the contaminant concentrations measured in the sediment samples were elevated significantly above background levels.
- One on site adit and one on site shaft represented hazardous openings. Several of the dumps appeared to have been reclaimed and several mine openings had been closed by Department of State Lands.



**Dry Gulch South PA# 29-282**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 07/20/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 29-282-SE-1 | 31 J          | 170 J         | 0.6 U         | 6.5 JX        | 14.5 JX       | 30.1 J        | 14200 J       | 0.309         | 592 J         | 21 J          | 38            | 7 UJ          | 76 JX         | NR                 |
| 29-282-SE-2 | 7 J           | 45.5 J        | 0.5 U         | 11.5 JX       | 37.4 JX       | 36.6 J        | 14400 J       | 0.13          | 331 J         | 50 J          | 7 U           | 5 UJ          | 40 JX         | NR                 |
| 29-282-WR-1 | 93 J          | 94.7 J        | 1.3           | 20.4 JX       | 71.6 JX       | 92.6 J        | 32600 J       | 0.453         | 614 J         | 104 J         | 469           | 6 UJ          | 190 JX        | NR                 |
| 29-282-WR-2 | 145 J         | 105 J         | 5.4           | 18.5 JX       | 57.8 JX       | 80.5 J        | 27400 J       | 1.01          | 1130 J        | 65 J          | 942           | 5 UJ          | 652 JX        | NR                 |
| BACKGROUND  | 25 J          | 260 J         | 1.1           | 6.9 JX        | 19.9 JX       | 32.4 J        | 15900 J       | 0.246         | 935 J         | 18 J          | 16            | 8 UJ          | 105 JX        | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID       | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|----------------|----------------------|---|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 29-282-SS-1    | 0.03                 | 0.94                                    | 136                           | 135                                       | <0.01                  | 0.01                   | 0.03                   | 0.31                                      | 136                                       |
| 29-282-WR-1    | 0.06                 | 1.87                                    | 119                           | 118                                       | 0.06                   | <0.01                  | <0.01                  | 0   | 119                                       |
| 29-282-WR-1DUP | 0.06                 | 1.87                                    | 122                           | 120                                       | 0.05                   | 0.01                   | <0.01                  | 0.31                                      | 122                                       |
| 29-282-WR-2    | 0.03                 | 0.94                                    | 78                            | 77.1                                      | 0.03                   | <0.01                  | <0.01                  | 0   | 78  |

**LEGEND**

SE1 - Upgradient in Dry Gulch.  
SE2 - Downgradient in Dry Gulch.  
WR1 - Composite of subsamples WRJF, KF, LF, GE, IF, FE, HE, HF, GF, EF, QE, and EE.  
WR2 - Composite of subsamples WRJE, CF, DE, DF, BE, BF, AE, and I.  
BACKGROUND - From Dry Gulch South (29-282-SS-1).  
WR1DUP - Duplicate of sample 29-282-WR-1.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Eleanora Mines (East)</u>          | County: <u>Madison</u>  |
| Legal Description: <u>T 3S R 5W</u>                   | Section(s): <u>3W 1/4, SE 1/4, Sec. 23; NW 1/4, NE 1/4, Sec. 26</u> |
| Mining District: <u>Tidal Wave</u>                    | Mine Type: <u>Hardrock/Unknown</u>                                  |
| Latitude: <u>N 45° 33' 10"</u>                        | Primary Drainage: <u>Jefferson River</u>                            |
| Longitude: <u>W 112° 10' 45"</u>                      | USGS Code: <u>10020005</u>  |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Goodrich Gulch</u>                           |
| Quad: <u>Old Baldy Mountain</u>                       | Date Investigated: <u>September 4, 1993</u>                         |
| Inspectors: <u>Bullock</u>                            | P.A. # <u>29-285</u>  |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no mill tailings associated with this site.
- This site was comprised of approximately 24 adits (20 of which are HMOs) and small associated waste rock dumps. The total volume of waste rock associated with this site was roughly estimated to be approximately 2500 cubic yards. The following elements were elevated at least three times background:

|                           |                           |
|---------------------------|---------------------------|
| Arsenic: 114J mg/kg       | Cadmium: 21 mg/kg         |
| Cobalt: 24.3 mg/kg        | Copper: 657 mg/kg         |
| Mercury: 1.13J mg/kg      | Manganese: 3160 mg/kg     |
| Lead: 236J to 5330J mg/kg | Zinc: 200J to 4650J mg/kg |
- There were no discharging adits, springs or seeps associated with this site.
- There were no direct runoff/flow paths down to Goodrich Gulch that impact this drainage. The dumps were very small with very minimal erosion occurring.

**Eleanor East PA# 29-285**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 09/04/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 29-285-WR-1 | 25.3 J        | 140 J         | 1 U           | 12.4          | 3.15          | 34            | 12600 J       | 0.185 J       | 921           | 26 J          | 236 J         | 6.06 UJ       | 200 J         | NR                 |
| 29-285-WR-2 | 114 J         | 132 J         | 21            | 24.3          | 17.2          | 657           | 46700 J       | 1.13 J        | 3160          | 50 J          | 5330 J        | 4.75 UJ       | 4650 J        | NR                 |
| BACKGROUND  | 25 J          | 260 J         | 1.1           | 6.9 JX        | 19.9 JX       | 32.4 J        | 15900 J       | 0.246         | 935 J         | 18 J          | 16            | 8 UJ          | 105 JX        | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL.<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|----------------------|---|--------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 29-285-WR-1 | 0.02                 | 0.62                                    | 6.23                           | 5.6                                       | 0.01                   | <0.01                  | 0.01                   | 0   | 6.23                                      |
| 29-285-WR-2 | 0.36                 | 11.2                                    | 31.5                           | 20.3                                      | 0.22                   | 0.05                   | 0.09                   | 1.56                                      | 30  |

**LEGEND**

WR1 - Composite of subsamples WR1 and 4.  
WR2 - Composite of subsamples WR2, 3, and 5.  
BACKGROUND - From the Dry Gulch South (29-282-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Pete &amp; Joe</u>   | County: <u>Madison</u>                    |
| Legal Description: T <u>3S</u> R <u>4W</u>  | Section(s): <u>SW 1/4, NW 1/4, Sec. 8</u> |
| Mining District: <u>Tidal Wave</u>  | Mine Type: <u>Hardrock/Ag, Au, Pb, Cu</u> |
| Latitude: <u>N 45° 35' 30"</u>  | Primary Drainage: <u>Currant Creek</u>    |
| Longitude: <u>W 112° 07' 40"</u>  | USGS Code: <u>10020005</u>                |
| Land Status: <u>Private/Public</u>  | Secondary Drainage: <u>Bear Gulch</u>     |
| Quad: <u>Old Baldy Mountain</u>   | Date Investigated: <u>July 23, 1993</u>   |
| Inspectors: <u>Babits, Lasher/Pierson</u>   | P.A. # <u>29-449</u>                      |
| Organization: <u>Pioneer Technical Services, Inc./ Thomas, Dean and Hoskins, Inc.</u> |   |

- There were no mill tailings associated with this site.
- There was approximately 2,835 cubic yards of uncovered waste rock at the site. The following were elevated at least 3 times background:  
Copper: 222J mg/kg  
Lead: 216J mg/kg
- There were two discharging adits at the site; neither entered surface water directly. Measured pH's were 7.6 (SW-1) and 5.13 (SW-4). Discharge SW-1 was sampled; no MCL/MCLGs or aquatic life criteria were exceeded.
- There was no surface water on site; the nearest surface water was 200 feet away. No surface water or sediment samples were collected.
- There were three open adits at the site.



**Pete & Joe PA# 29-449**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/23/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 29-449-WR-1 | 152        | 133 J      | 2.3        | 6.5 J      | 35.6       | 222 J      | 41900      | 1.18 J     | 423        | 20 J       | 216 J      | 7 U        | 135 J      | NR              |
| BACKGROUND  | 103        | 94         | 1.8        | 19.8       | 100        | 57.4       | 34300      | 1.23 J     | 606 J      | 61.4       | 31.9       | 16.9       | 70.6       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 29-449-WR-1 | 1.03           | 32.2                           | 3.2                      | -29                              | 0.67             | 0.16             | 0.2              | 5                                | -1.8                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba      | Cd     | Co    | Cr     | Cu     | Fe    | Hg      | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|---------|--------|-------|--------|--------|-------|---------|------|--------|--------|--------|-----------------|----------------|
| 29-449-SW-1 | 1.23 | 11.6 JX | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 168 J | 0.038 U | 66.6 | 12.7 U | 0.72 U | 30.7 U | 16 J            | 157            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD I.D.  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 29-449-SW-1 | 240                    | < 5.0    | 75      | < 0.05    | NR      |

**LEGEND**

WR1 - Composite of subsamples WR1, 2A, 2B, 3, and 4.

SW1 - Discharge from adit at waste rock dump 1.

BACKGROUND - From the Lakeshore Mine (29-436-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Ohio</u>                           | County: <u>Madison</u>                        |
| Legal Description: <u>T 2S R 5W</u>                   | Section(s): <u>SE 1/4, NE 1/4, Sec. 25</u>    |
| Mining District: <u>Tidal Wave</u>                    | Mine Type: <u>Hardrock/Au</u>                 |
| Latitude: <u>N 45° 38' 05"</u>                        | Primary Drainage: <u>Jefferson River</u>      |
| Longitude: <u>W 112° 09' 25"</u>                      | USGS Code: <u>10020005</u>                    |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Hellroaring Canyon</u> |
| Quad: <u>Waterloo</u>                                 | Date Investigated: <u>July 20, 1993</u>       |
| Inspectors: <u>Tuesday, Belanger, Clark</u>           | P.A. # <u>29-473</u>                          |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no mill tailings observed at this site during the investigation.
- The total volume of waste rock associated with this site (including WR-3 which was previously reclaimed) was estimated to be approximately 1,530 cubic yards. The following elements were elevated at least three times background:

|                      |                    |
|----------------------|--------------------|
| Cadmium: 3.3 mg/kg   | Copper: 126J mg/kg |
| Mercury: 0.797 mg/kg | Lead: 322 mg/kg    |
| Zinc: 109JX mg/kg    |                    |
- There were no adit discharges, filled shafts, seeps, or springs observed at the site during the investigation; consequently, no groundwater or surface water samples were collected.
- Intermittent Hellroaring Canyon was situated within approximately 20 feet of the toe of the reclaimed waste rock dump.

Ohio PA# 29-473  
AMRB HAZARDOUS MATERIALS INVENTORY  
INVESTIGATOR: PIONEER - TUESDAY  
INVESTIGATION DATE: 07/20/93

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 29-473-WR-1 | 36 J          | 205 J         | 3.3           | 5.1 JX        | 10.4 JX       | 126 J         | 14200 J       | 0.797         | 1790 J        | 14 J          | 322           | 12 J          | 701 JX        | NR                 |
| BACKGROUND  | 25 J          | 260 J         | 1.1           | 6.9 JX        | 19.9 JX       | 32.4 J        | 15900 J       | 0.246         | 935 J         | 18 J          | 16            | 8 UJ          | 105 JX        | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|----------------------|---|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 29-473-WR-1 | <0.01                | 0                                       | 295                           | 295                                       | <0.01                  | <0.01                  | 0.02                   | 0   | 295                                       |

**LEGEND**

WR1 - Composite of subsamples WR1, 2, and 3.  
BACKGROUND - From the Dry Gulch South (29-282-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |   |
|--|---|
| Mine/Site Name: <u>Kearsage</u><br>Legal Description: T <u>7S</u> R <u>3W</u><br>Mining District: <u>Virginia City</u><br>Latitude: <u>N 45° 13' 00"</u><br>Longitude: <u>W 111° 56' 00"</u><br>Land Status: <u>Private</u><br>Quad: <u>Cirque Lake</u><br>Inspectors: <u>Babits, Lasher/Pierson</u><br>Organization: <u>Pioneer Technical Services,<br/>Inc./Thomas, Dean and Hoskins, Inc.</u> | County: <u>Madison</u><br>Section(s): <u>NW 1/4, NE 1/4, Sec. 23</u><br>Mine Type: <u>Hardrock/Au</u><br>Primary Drainage: <u>Alder Gulch</u><br>USGS Code: <u>10020003</u><br>Secondary Drainage: <u>Mill Gulch</u><br>Date Investigated: <u>July 20, 1993</u><br>P.A. # <u>29-102</u> |
|--|---|

- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 8,780 cubic yards. The following elements were elevated at least three times background:

|                     |                           |
|---------------------|---------------------------|
| Arsenic: 25 mg/kg   | Cadmium: 6.8J mg/kg       |
| Chromium: 482 mg/kg | Copper: 78.1 to 111 mg/kg |
| Nickel: 224 mg/kg   | Lead: 41 mg/kg            |
| Zinc: 234 mg/kg     |                           |
- No discharging adits, filled shafts, seeps, or springs were identified at the site.
- Mill Gulch was flowing adjacent to the site on the north side during the investigation. Surface water and sediment samples were collected upstream and downstream from the site in Mill Gulch. No MCLs or acute or chronic aquatic life criteria were exceeded in Mill Gulch.
- Observed releases to Mill Gulch (sediment) were documented for cadmium, lead, and zinc.
- Potentially hazardous mine openings identified at the site included one open adit and one open shaft. The shaft was surrounded by a barbed wire fence.



**Kearsage PA# 29-102**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/20/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 29-102-SE-1 | 5 U        | 54.4       | 0.9 J      | 9.1        | 31.7       | 17.7       | 12900      | 0.244      | 181        | 22         | 16         | 6 U        | 41         | 0.338 U         |
| 29-102-SE-2 | 5 U        | 111        | 2.8 J      | 18.5       | 83         | 41.2       | 26200      | 0.461      | 354        | 49         | 80         | 7 U        | 124        | 0.338 U         |
| 29-102-WR-1 | 25         | 122        | 6.8 J      | 45         | 160        | 78.1       | 61500      | 0.392      | 883        | 100        | 41         | 5 U        | 234        | NR              |
| 29-102-WR-2 | 11         | 232        | 4.8 J      | 46.8       | 482        | 111        | 52200      | 0.679      | 452        | 224        | 29         | 5 U        | 183        | NR              |
| BACKGROUND  | 6 U        | 155        | 2.2 J      | 17         | 71.1       | 14.5       | 24800      | 0.255      | 821        | 46         | 13         | 8 U        | 73         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 29-102-WR-1 | 0.59           | 18.4                           | 76.6                    | 58.1                             | <0.01            | 0.5              | 0.16             | 15.6                             | 60.9                             |
| 29-102-WR-2 | <0.01          | 0                              | 17.6                    | 17.6                             | <0.01            | <0.01            | 0.03             | 0                                | 17.6                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu     | Fe  | Hg      | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|--------|-------|--------|--------|-----|---------|------|--------|--------|--------|-----------------|----------------|
| 29-102-SW-1 | 1.69 U | 30.5 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 262 | 0.038 U | 8.53 | 12.7 U | 1.55 U | 30.7 U | 7.57 U          | 83.6           |
| 29-102-SW-2 | 1.69 U | 31.7 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 319 | 0.038 U | 9.4  | 12.7 U | 1.55 U | 30.7 U | 7.57 U          | 85.3           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 29-102-SW-1 | 118                    | < 5.0    | 8       | < 0.05    | NR      |
| 29-102-SW-2 | 126                    | < 5.0    | 8       | < 0.05    | NR      |

**LEGEND**

SE1 - 300 feet upgradient from waste rock dump 1 in Mill Gulch.  
SE2 - At PPE in Mill Gulch of waste rock dump 1.  
WR1 - Composite of subsamples WR1A, 1B, and 1C.  
WR2 - Composite of subsamples WR2A, 2B, 3, 4, and 5.  
BACKGROUND - From the Apex Mine (29-105-SS-1).

SW1 - Same as SE1.  
SW2 - Same as SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: General Shafter  
Legal Description: T 7S R 3W  
Mining District: Virginia City  
Latitude: N 45° 12' 05"  
Longitude: W 111° 56' 03"  
Land Status: Private  
Quad: Cirque Lake  
Inspectors: Babits, Lasher/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Madison  
Section(s): SW 1/4, NW 1/4, Sec. 23  
Mine Type: Hardrock/Au  
Primary Drainage: Alder Gulch  
USGS Code: 10020003  
Secondary Drainage: Mill Gulch  
Date Investigated: July 21, 1993  
P.A. # 29-103

- The volume of tailings associated with this site was estimated to be approximately 300 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 16 mg/kg                      Copper: 178 mg/kg  
Mercury: 1.97 mg/kg                      Lead: 521 mg/kg  
Antimony: 52 mg/kg                      Zinc: 421 mg/kg  
Cyanide: 9.72 mg/kg
- The volume of waste rock associate with this site was estimated to be approximately 9,900 cubic yards. The following elements were elevated at least three times background:  
Lead: 109 mg/kg
- One discharging adit was identified at the site. The adit discharge eventually entered Mill Gulch. No MCLs or acute or chronic aquatic life criteria were exceeded in the adit discharge.
- Mill Gulch was flowing adjacent to the site on the south side. Surface water and sediment samples were collected upstream and downstream from the site in Mill Gulch. No MCLs or acute or chronic aquatic life criteria were exceeded, and metals concentrations in the downstream sediment sample were not elevated above upstream concentrations.
- No hazardous mine openings were identified at the site.

**General Shafter PA# 29-103**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/21/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 29-102-SE-1 | 5 U        | 54.4       | 0.9 J      | 9.1        | 31.7       | 17.7       | 12900      | 0.244      | 181        | 22         | 16         | 6 U        | 41         | 0.338 U         |
| 29-103-SE-1 | 6          | 63.7       | 1.2 J      | 12.2       | 51.3       | 18.2       | 14800      | 0.344      | 243        | 30         | 14         | 7 U        | 62         | NR              |
| 29-103-TP-1 | 16         | 40.7       | 4.3 J      | 10.1       | 9.4        | 178        | 9730       | 1.97       | 261        | 21         | 521        | 52         | 421        | 9.72            |
| 29-103-WR-1 | 11         | 54.5       | 2.3 J      | 11         | 24.4       | 39.1       | 15100      | 0.704      | 591        | 28         | 109        | 6 U        | 139        | NR              |
| BACKGROUND  | 6 U        | 155        | 2.2 J      | 17         | 71.1       | 14.5       | 24800      | 0.255      | 821        | 46         | 13         | 8 U        | 73         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 29-103-TP-1 | 0.01           | 0.31                           | 22.8                    | 22.4                             | <0.01            | 0.01             | 0.01             | 0.31                             | 22.4                             |
| 29-103-WR-1 | 0.03           | 0.94                           | 102                     | 101                              | <0.01            | 0.04             | 0.05             | 1.25                             | 101                              |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu     | Fe   | Hg      | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|--------|-------|--------|--------|------|---------|------|--------|--------|--------|-----------------|----------------|
| 29-102-SW-1 | 1.69 U | 30.5 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 262  | 0.038 U | 8.53 | 12.7 U | 1.55 U | 30.7 U | 7.57 U          | 83.6           |
| 29-103-SW-1 | 1.69 U | 18.2 | 2.57 U | 9.7 U | 9.1    | 1.55 U | 74.1 | 0.038 U | 5.13 | 12.7 U | 1.55 U | 30.7 U | 7.57 U          | 51.2           |
| 29-103-SW-2 | 1.69 U | 47.9 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 34.6 | 0.038 U | 5.5  | 12.7 U | 1.55 U | 30.7 U | 7.57 U          | 222            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 29-102-SW-1 | 118                    | < 5.0    | 8       | < 0.05    | NR      |
| 29-103-SW-1 | 97                     | < 5.0    | 5       | 0.1       | NR      |
| 29-103-SW-2 | 260                    | < 5.0    | 26      | 0.31      | NR      |

**LEGEND**

29-102-SE1 - Upgradient of Kearsage; downgradient for General Shafter.  
29-103-SE1 - Upgradient of mill building in Mill Gulch.  
TP1 - Composite of subsamples TP1A and 1B.  
WR1 - Composite of subsamples WR1A, 1B, and 2.  
BACKGROUND - From the Apex Mine (29-105-SS-1).

29-102-SW1 - Same as 29-102-SE1.  
29-103-SW1 - Same as 29-103-SE1.  
SW2 - Adit discharge on Mill Gulch.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |   |
|--|---|
| Mine/Site Name: <u>Apex</u>  | County: <u>Madison</u>                      |
| Legal Description: <u>T 7S R 3W</u>  | Section(s): <u>Center of N 1/2, Sec. 23</u> |
| Mining District: <u>Virginia City</u>  | Mine Type: <u>Hardrock/Au, Talc</u>         |
| Latitude: <u>N 45° 12' 05'</u>   | Primary Drainage: <u>Ruby River</u>         |
| Longitude: <u>W 111° 56' 00</u>  | USGS Code: <u>10020005</u>                  |
| Land Status: <u>Private</u>  | Secondary Drainage: <u>Alder Gulch</u>      |
| Quad: <u>Cirque Lake</u>   | Date Investigated: <u>July 20, 1993</u>     |
| Inspectors: <u>Babits, Lasher/Pierson</u>  | P.A. # <u>29-105</u>                        |
| Organization: <u>Pioneer Technical Services,<br/>Inc./Thomas, Dean and Hoskins, Inc.</u> |   |

- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 6,960 cubic yards. The following elements were elevated at least three times background:

|                           |                              |
|---------------------------|------------------------------|
| Arsenic: 7 to 53 mg/kg    | Cadmium: 7.2J to 14.3J mg/kg |
| Copper: 70.2 to 100 mg/kg | Lead: 210 to 212 mg/kg       |
| Zinc: 260 to 1,030 mg/kg  |                              |
- One discharging adit was identified at the site during the investigation. However, the adit was actively being worked and could not be sampled due to inaccessibility.
- Alder Gulch was flowing adjacent to the site on the east side during the investigation. Surface water and sediment samples were collected upstream and downstream from the site in Alder Gulch; no MCLs or acute or chronic aquatic life criteria were exceeded.
- Potentially hazardous mine openings identified at the site included three open adits and one open shaft. The shaft was surrounded by a barbed wire fence.



**Apex Mine PA# 29-105**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/20/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 29-105-SE-1 | 8 U        | 118        | 2.1 J      | 16.7       | 119        | 25.9       | 29400      | 0.486      | 408        | 60         | 17         | 10 U       | 95         | NR              |
| 29-105-SE-2 | 9 U        | 63.3       | 1.6 J      | 19.8       | 51.3       | 32.5       | 26600      | 0.488      | 403        | 37         | 22         | 11 U       | 86         | NR              |
| 29-105-WR-1 | 7          | 190        | 3.1 J      | 28.5       | 88.7       | 70.2       | 33100      | 0.345      | 387        | 73         | 12         | 6 U        | 66         | NR              |
| 29-105-WR-2 | 33         | 193        | 7.2 J      | 36.2       | 105        | 83.4       | 49800      | 0.502      | 940        | 81         | 210        | 6 U        | 260        | NR              |
| 29-105-WR-3 | 53         | 29.7       | 14.3 J     | 35.9       | 80.6       | 100        | 54200      | 0.552      | 941        | 92         | 212        | 5 U        | 1030       | NR              |
| BACKGROUND  | 6 U        | 155        | 2.2 J      | 17         | 71.1       | 14.5       | 24800      | 0.255      | 821        | 46         | 13         | 8 U        | 73         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID       | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|----------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 29-105-WR-1DUP | 0.22           | 6.87                           | 72.9                     | 66.1                             | <0.01            | 0.16             | 0.12             | 5                                | 67.9                             |
| 29-105-WR-1    | 0.23           | 7.19                           | 73.5                     | 66.3                             | <0.01            | 0.14             | 0.13             | 4.37                             | 69.1                             |
| 29-105-WR-2    | 0.26           | 8.12                           | 60.7                     | 52.6                             | <0.01            | 0.16             | 0.12             | 5                                | 55.7                             |
| 29-105-WR-3    | 1.12           | 35                             | 75.5                     | 40.5                             | <0.01            | 1.11             | 0.37             | 34.7                             | 40.8                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu     | Fe   | Hg      | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|--------|-------|--------|--------|------|---------|--------|--------|--------|--------|-----------------|----------------|
| 29-105-SW-1 | 1.69 U | 32.6 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 17.3 | 0.038 U | 4.08 U | 12.7 U | 1.55 U | 30.7 U | 7.57 U          | 183            |
| 29-105-SW-2 | 1.69 U | 34.6 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 42   | 0.038 U | 4.08 U | 12.7 U | 1.55 U | 30.7 U | 7.57 U          | 186            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 29-105-SW-1 | 244                    | < 5.0    | 7       | 0.17      | NR      |
| 29-105-SW-2 | 211                    | < 5.0    | 7       | 0.21      | NR      |

**LEGEND**

SE1 - Approx 1,000' upgradient from waste rock dump 6 in Alder Gulch.  
SE2 - Approx. 50' downgradient from waste rock dump 6.  
WR1 - Composite of subsamples WR-1A through 1C.  
WR2 - Composite of subsamples WR2A, 2B, 3A, 3B, and 4.  
(See JTC 29-106 for WR4 information).  
WR3 - Composite of subsamples WR5 and 6.  
BACKGROUND - From the Apex (29-105-SS-1).

WR1DUP - Duplicate of sample 29-105-WR-1.  
SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |  |
|--|--|
| Mine/Site Name: <u>JTC</u>   | County: <u>Madison</u>                     |
| Legal Description: <u>T 7S R 3W</u>  | Section(s): <u>NW 1/4, SW 1/4, Sec. 23</u> |
| Mining District: <u>Virginia City</u>  | Mine Type: <u>Hardrock/Au</u>              |
| Latitude: <u>N 45° 12' 04"</u>   | Primary Drainage: <u>Ruby River</u>        |
| Longitude: <u>W 111° 56' 01"</u>   | USGS Code: <u>10020003</u>                 |
| Land Status: <u>Private</u>  | Secondary Drainage: <u>Alder Gulch</u>     |
| Quad: <u>Cirque Lake</u>   | Date Investigated: <u>August 27, 1993</u>  |
| Inspectors: <u>Babits, Flammang/Pierson</u>  | P.A. # <u>29-106</u>                       |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |  |

- No mill tailings were observed at the site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 375 cubic yards. The following elements were elevated at least three times background:  
Copper: 51.9 mg/kg
- No discharging adits were identified at the site; however, one adit contained standing water. This water was sampled for field parameters only; the pH measurement was 8.14.
- Alder Gulch was flowing adjacent to the site on the east side during the investigation. Surface water and sediment samples were collected downstream from the site (see analytical data for the Apex Mine #29-105). No MCLs or acute or chronic aquatic life criteria were exceeded downstream from the site.
- One potentially hazardous open adit and a 50 feet tall highwall were identified at the site.

**J.T.C. PA# 29-106**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/27/93**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 29-106-WR-1 | 7.5 J         | 89.4          | 1.28 J        | 30.3          | 112           | 51.9          | 37200         | 0.343 J       | 362           | 62.7          | 30.1          | 5.4 U         | 163           | NR                 |
| BACKGROUND  | 6 U           | 155           | 2.2 J         | 17            | 71.1          | 14.5          | 24800         | 0.255         | 821           | 46            | 13            | 8 U           | 73            | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID       | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|----------------|----------------------|---|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 29-106-WR-1DUP | 0.3                  | 9.37                                    | 40.8                          | 31.5                                      | 0.04                   | 0.13                   | 0.13                   | 4.06                                      | 36.8                                      |
| 29-106-WR-1    | 0.3                  | 9.37                                    | 41.7                          | 32.3                                      | 0.03                   | 0.13                   | 0.14                   | 4.06                                      | 37.6                                      |

**LEGEND**

WR1 - Composite of subsamples WR1A and 1B.  
BACKGROUND - From the Apex Mine (29-105-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Pacific</u>                        | County: <u>Madison</u>                    |
| Legal Description: <u>T 7S R 3W</u>                   | Section(s): <u>NW 1/4, Sec. 15</u>        |
| Mining District: <u>Virginia City</u>                 | Mine Type: <u>Hardrock/Au, Ag</u>         |
| Latitude: <u>N 45° 13' 45"</u>                        | Primary Drainage: <u>Alder Gulch</u>      |
| Longitude: <u>W 111° 57' 03"</u>                      | USGS Code: <u>10020003</u>                |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Browns Gulch</u>   |
| Quad: <u>Cirque Lake</u>                              | Date Investigated: <u>August 26, 1993</u> |
| Inspectors: <u>Babits, Flammang/Pierson</u>           | P.A. # <u>29-118</u>                      |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 190,000 cubic yards. The following elements were elevated at least three times background:

|                      |                                 |
|----------------------|---------------------------------|
| Cadmium: 0.88J mg/kg | Chromium: 286JX mg/kg           |
| Copper: 112 mg/kg    | Mercury: 0.071J to 0.253J mg/kg |
| Nickel: 149JX mg/kg  | Lead: 30.8JX mg/kg              |
- Three discharging adits were identified at the site during the investigation. Two of the discharges eventually flowed into Brown's Gulch; one of these discharges was sampled for laboratory analyses. No MCLs were exceeded in the adit discharge; however, the chronic aquatic life criteria for mercury was exceeded.
- Brown's Gulch was flowing through the center of the site during the investigation. Surface water and sediment samples were collected upstream and downstream from the site in Brown's Gulch. No MCLs were exceeded; however, the chronic aquatic life criteria for mercury was exceeded in both the upstream and downstream samples. An observed release to Brown's Gulch was documented for lead. Additionally, observed releases to Brown's Gulch (sediment) were documented for mercury and lead.
- Three potentially hazardous open adits and one 200 feet tall highwall were identified at the site.



**Pacific PA# 29-118**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/26/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 29-118-SE-1 | 6.99       | 110 J      | 1.37 J     | 11.5       | 33.8 JX    | 26.3       | 24600      | 0.056 J    | 444 J      | 30.9 JX    | 38.2 JX    | 6.91 UJ    | 110 J      | NR              |
| 29-118-SE-2 | 7.35       | 356 J      | 2.57 J     | 14.1       | 18.7 JX    | 62.6       | 27200      | 0.437 J    | 424 J      | 24.9 JX    | 189 JX     | 6.9 UJ     | 310 J      | NR              |
| 29-118-WR-1 | 7.42       | 91.2 J     | 0.88 J     | 24.2       | 286 JX     | 112        | 34400      | 0.253 J    | 494 J      | 149 JX     | 20.8 JX    | 5.86 UJ    | 74.9 J     | NR              |
| 29-118-WR-2 | 4.49 U     | 100 J      | 0.86 UJ    | 11.1       | 21.2 JX    | 31.8       | 25700      | 0.072 J    | 490 J      | 24.2 JX    | 30.8 JX    | 5.93 UJ    | 91.7 J     | NR              |
| BACKGROUND  | 12.8       | 123 J      | 1.02 UJ    | 8.77       | 22.4 JX    | 26.4       | 22400      | 0.031 UJ   | 539 J      | 16.4 JX    | 7.26 UJX   | 7.01 UJ    | 52.4 J     | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 29-118-WR-1 | 0.08           | 2.5                            | 76.4                    | 73.9                             | <0.01            | 0.04             | 0.04             | 1.25                             | 75.2                             |
| 29-118-WR-2 | 0.3            | 9.37                           | 140                     | 131                              | 0.07             | 0.04             | 0.19             | 1.25                             | 139                              |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu     | Fe     | Hg      | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|--------|-------|--------|--------|--------|---------|------|--------|--------|--------|-----------------|----------------|
| 29-118-SW-1 | 1.12 U | 32.2 | 4.59 U | 5 U   | 6.24 U | 3.67 J | 59.6 J | 0.2     | 7.47 | 10.9 U | 0.94 U | 31.7 U | 33.5            | 105            |
| 29-118-SW-2 | 1.08   | 66.9 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 251    | 0.16 JX | 55.8 | 12.7 U | 3.66 J | 30.7 U | 27.8 J          | 171            |
| 29-118-SW-3 | 1.83   | 99.3 | 2.57 U | 9.7 U | 6.83 U | 1.97   | 900    | 0.14 JX | 174  | 13.8   | 1.98 J | 30.7 U | 36.1 J          | 233            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 29-118-SW-1 | 114                    | < 5.0    | 8       | NR        | NR      |
| 29-118-SW-2 | 1080                   | < 5.0    | 2424    | 0.05      | NR      |
| 29-118-SW-3 | 268                    | < 5.0    | 38      | < 0.05    | NR      |

**LEGEND**

SE1 - 400 feet upgradient of waste rock dump 2.

SE2 - 50 feet downgradient of culvert where creek crosses road at base of waste rock dump 1.

WR1 - Composite of subsamples WR1A, 1B, and 1C.

WR2 - Composite of subsamples WR2A, 2B, 3A, 3B, 4A, and 4B.

BACKGROUND - 275' above waste rock dump 4. From Pacific (29-118-SS-1).

SW1 - Same as sample SE1.

SW2 - Same as sample SE2.

SW3 - Adit discharge across road from waste rock dump 1.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Easton  
Legal Description: T 7S R 3W  
Mining District: Virginia City  
Latitude: N 45° 15.0'  
Longitude: W 111° 58.1  
Land Status: Private  
Quad: Virginia City/Cirque Lake  
Inspectors: Babits, Flammang/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Madison  
Section(s): SE 1/4, SE 1/4, Sec. 4  
Mine Type: Hardrock/Au, Ag  
Primary Drainage: Alder Gulch  
USGS Code: 10020003  
Secondary Drainage: Browns Gulch  
Date Investigated: August 26, 1993  
P.A. # 29-121

- The volume of tailings associated with this site was estimated to be approximately 1,500 cubic yards. The following elements were elevated at least three times background:

|                      |                     |
|----------------------|---------------------|
| Arsenic: 52.9 mg/kg  | Barium: 455J mg/kg  |
| Cadmium: 45.2J mg/kg | Copper: 489 mg/kg   |
| Mercury: 1.47J mg/kg | Lead: 2,670JX mg/kg |
| Antimony: 107J mg/kg | Zinc: 3,650J mg/kg  |
- The volume of waste rock associate with this site was estimated to be approximately 7,100 cubic yards. The following elements were elevated at least three times background:

|                    |                      |
|--------------------|----------------------|
| Copper: 111 mg/kg  | Mercury: 0.18J mg/kg |
| Lead: 94.2JX mg/kg | Zinc: 158J mg/kg     |
- One discharging adit was identified at the site; this discharge eventually entered Mill Creek. No MCLs were exceeded in the adit discharge; however, the chronic aquatic life criteria for mercury was exceeded. The pH measurement in the adit discharge was 7.5.
- Mill Creek was flowing through the center of the site during the investigation. Surface water and sediment samples were collected upstream and downstream from the site in Mill Creek. No MCLs were exceeded in Mill Creek; however, the chronic aquatic life criteria for mercury was exceeded in both the upstream and downstream samples.
- One potentially hazardous partially collapsed adit was identified at the site.

**Easton PA# 29-121**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/26/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 29-121-SE-1 | 4.56 U     | 33.4 J     | 0.88 UJ    | 3.2        | 9.06 JX    | 5.67       | 11200      | 0.036 J    | 98.4 J     | 6.86 JX    | 7.67 JX    | 6.04 UJ    | 38.9 J     | NR              |
| 29-121-SE-2 | 5.48 U     | 23.1 J     | 1.05 UJ    | 2.08       | 6.91 JX    | 6.93       | 8320       | 0.034 J    | 125 J      | 5.7 JX     | 14.3 JX    | 7.24 UJ    | 60.2 J     | NR              |
| 29-121-TP-1 | 52.9       | 455 J      | 45.20 J    | 6.43       | 10.6 JX    | 489        | 27900      | 1.47 J     | 273 J      | 22.9 JX    | 2670 JX    | 107 J      | 3650 J     | <0.306          |
| 29-121-WR-1 | 25         | 257 J      | 1.87 J     | 10.5       | 10.6 JX    | 111        | 30100      | 0.18 J     | 406 J      | 25.6 JX    | 94.2 JX    | 11.8 J     | 158 J      | NR              |
| BACKGROUND  | 12.8       | 123 J      | 1.02 UJ    | 8.77       | 22.4 JX    | 26.4       | 22400      | 0.031 UJ   | 539 J      | 16.4 JX    | 7.26 UJX   | 7.01 UJ    | 52.4 J     | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 29-121-TP-1 | 1.23           | 38.4                           | 47.1                    | 8.69                             | 0.48             | 0.74             | 0.01             | 23.1                             | 24                               |
| 29-121-WR-1 | 0.66           | 20.6                           | 62                      | 41.4                             | 0.13             | 0.34             | 0.19             | 10.6                             | 51.4                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co  | Cr     | Cu     | Fe     | Hg   | Mn   | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|--------|-----|--------|--------|--------|------|------|--------|------|--------|-----------------|----------------|
| 29-121-SW-1 | 1.12 U | 73   | 4.59 U | 5 U | 6.24 U | 2.33 U | 296 J  | 0.22 | 11.8 | 10.9 U | 3.18 | 31.7 U | 8.71 U          | 129            |
| 29-121-SW-2 | 1.12 U | 78.4 | 4.59 U | 5 U | 6.24 U | 2.33 U | 270 J  | 0.2  | 11   | 10.9 U | 3.78 | 31.7 U | 19.7            | 360            |
| 29-121-SW-3 | 1.32   | 55   | 4.59 U | 5 U | 6.24 U | 3.8 J  | 51.9 J | 0.27 | 5    | 10.9 U | 0.99 | 31.7 U | 34.1            | 814            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 29-121-SW-1 | 164                    | < 5.0    | 39      | < 0.05    | NR      |
| 29-121-SW-2 | 403                    | < 5.0    | 116     | < 0.16    | NR      |
| 29-121-SW-3 | 901                    | < 5.0    | 249     | < 0.05    | NR      |

**LEGEND**

SE1 - 50 feet upgradient above last cabin.  
SE2 - Downgradient of waste rock dump 2.  
TP1 - Composite of subsamples TP1A and 1B.  
WR1 - Composite of subsamples WR1A, 1B, 1C, 2A, and 2B.  
BACKGROUND - From the Pacific Mine (29-118-SS-1).

SW1 - Same as SE1.  
SW2 - Same as SE2.  
SW3 - Discharge from adit #1.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |   |
|--|---|
| Mine/Site Name: <u>Missouri</u>  | County: <u>Madison</u>                                    |
| Legal Description: <u>T 4S R 2W</u>  | Section(s): <u>N 1/2, NE 1/4, Sec. 30; S 1/2, Sec. 29</u> |
| Mining District: <u>Washington</u>   | Mine Type: <u>Hardrock/Au, Ag, Pb, Cu</u>                 |
| Latitude: <u>N 45° 27' 32"</u>   | Primary Drainage: <u>Madison River</u>                    |
| Longitude: <u>W 111° 53' 27"</u>   | USGS Code: <u>10020007</u>                                |
| Land Status: <u>Private/Public</u>   | Secondary Drainage: <u>South Meadow Creek</u>             |
| Quad: <u>Ramshorn Mountain</u>   | Date Investigated: <u>July 22, 1993</u>                   |
| Inspectors: <u>Babits, Lasher/Pierson</u>  | P.A. # <u>29-373</u>                                      |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |   |

- The volume of tailings associated with this site was estimated to be approximately 12,111 cubic yards. The following elements were elevated at least three times background:

|                               |                            |
|-------------------------------|----------------------------|
| Arsenic: 3,390 to 6,520 mg/kg | Cadmium: 3.6 to 10.6 mg/kg |
| Copper: 364 to 692 mg/kg      | Iron: 79,100 mg/kg         |
| Mercury: 0.791 to 3.68 mg/kg  | Lead: 536 to 11,900 mg/kg  |
| Antimony: 76 to 107 mg/kg     | Zinc: 426 to 1,080 mg/kg   |
- The volume of waste rock associated with this site was estimated to be approximately 5,960 cubic yards. The following elements were elevated at least three times background:

|                      |                               |
|----------------------|-------------------------------|
| Arsenic: 1,730 mg/kg | Cadmium: 9.8 mg/kg            |
| Copper: 255 mg/kg    | Mercury: 0.285 to 0.897 mg/kg |
| Lead: 3,520 mg/kg    | Antimony: 38 mg/kg            |
| Zinc: 682 mg/kg      |                               |
- No discharging adits, filled shafts, seeps, or springs were identified at the site.
- South Meadow Creek was flowing adjacent to the site on the south side. Surface water and sediment samples were collected upstream and downstream from the site in South Meadow Creek. No MCLs were exceeded in South Meadow Creek; however, the chronic aquatic life criteria for lead was exceeded in both the upstream and downstream samples.
- Observed releases to South Meadow Creek (sediment) were documented for arsenic and lead.
- Two potentially hazardous open adits were identified at the site.



**Missouri PA# 29-373**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/22/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 29-373-SE-1 | 16         | 86.7       | 0.5 U      | 8.5        | 38.1       | 17.6       | 13000      | 0.054      | 362 J      | 22         | 42         | 6 U        | 57         | 0.323 U         |
| 29-373-SE-2 | 290        | 68.6       | 0.6 U      | 11         | 41.2       | 45.3       | 20300      | 0.089      | 249 J      | 32         | 536        | 9          | 99         | 0.397 U         |
| 29-373-TP-1 | 6520       | 92.7       | 10.6       | 8          | 51.5       | 692        | 79100      | 3.68       | 138 J      | 18         | 11900      | 107        | 1080       | 0.317           |
| 29-373-TP-2 | 3390       | 35.2       | 3.6        | 4.3        | 24.5       | 364        | 44000      | 0.791      | 76.1 J     | 8          | 6680       | 76         | 426        | 0.308           |
| 29-373-WR-1 | 1730       | 103        | 9.8        | 28.5       | 34.3       | 255        | 47400      | 0.897      | 784 J      | 47         | 3520       | 38         | 682        | NR              |
| 29-373-WR-2 | 5          | 219        | 0.5 U      | 34.9       | 76.2       | 65.3       | 30700      | 0.285      | 330 J      | 62         | 12         | 5 U        | 59         | NR              |
| BACKGROUND  | 10         | 129        | 0.6 U      | 16.6       | 57.6       | 28.4       | 21600      | 0.029      | 951 J      | 51         | 23         | 7 U        | 54         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 29-373-TP-1 | 0.31           | 9.68                           | 5.88                    | -3.8                             | 0.31             | <0.01            | <0.01            | 0                                | 5.88                             |
| 29-373-TP-2 | 0.19           | 5.94                           | 2.73                    | -3.2                             | 0.19             | <0.01            | <0.01            | 0                                | 2.73                             |
| 29-373-WR-1 | 0.07           | 2.19                           | 28.9                    | 26.7                             | 0.07             | <0.01            | <0.01            | 0                                | 28.9                             |
| 29-373-WR-2 | 0.01           | 0                              | 7.11                    | 7.11                             | <0.01            | <0.01            | <0.01            | 0                                | 7.11                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba      | Cd     | Co    | Cr     | Cu     | Fe     | Hg      | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|---------|--------|-------|--------|--------|--------|---------|--------|--------|--------|--------|-----------------|----------------|
| 29-373-SW-1 | 2.34 | 12.3 JX | 2.57 U | 9.7 U | 6.97 J | 1.63 J | 43.7 J | 0.038 U | 4.08 U | 12.7 U | 0.72 U | 30.7 U | 7.57 U          | 20             |
| 29-373-SW-2 | 3.35 | 12.3 JX | 2.57 U | 9.7 U | 6.83 U | 1.7 J  | 48.6 J | 0.038 U | 4.08 U | 12.7 U | 0.89 J | 30.7 U | 7.57 U          | 23.1           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 29-373-SW-1 | 75                     | < 5.0    | < 5.0   | < 0.05    | NR      |
| 29-373-SW-2 | 71                     | < 5.0    | < 5.0   | < 0.05    | < 0.01  |

**LEGEND**

SE1 - 800 feet upgradient of tailings pond 1 in S. Meadow Creek.  
SE2 - At PPE of tailings pond 1 in S. Meadow Creek.  
TP1 - Composite of subsamples TP1A-C and 1A-B.  
TP2 - Composite of subsamples TP1A-C and 1A-D.  
WR1 - Composite of subsamples WR1, 2A, 2B, 3A, and 3B.  
WR2 - Composite of subsamples WR4, 5, and 6.  
BACKGROUND - From the Missouri Mine (29-373-SS-1).

SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>SE SE S25</u>                      | County: <u>Madison</u>                        |
| Legal Description: <u>T 4S R 3W</u>                   | Section(s): <u>SE 1/4, SE 1/4, Sec. 25</u>    |
| Mining District: <u>Washington</u>                    | Mine Type: <u>Hardrock/Unknown</u>            |
| Latitude: <u>N 45° 27' 18"</u>                        | Primary Drainage: <u>Madison River</u>        |
| Longitude: <u>W 111° 54' 20"</u>                      | USGS Code: <u>10020007</u>                    |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>South Meadow Creek</u> |
| Quad: <u>Ramshorn Mountain</u>                        | Date Investigated: <u>September 20, 1993</u>  |
| Inspectors: <u>M. Babits, S. Babits</u>               | P.A. # <u>29-394</u>                          |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 4,600 cubic yards. The following elements were elevated at least three times background:

|                      |                   |
|----------------------|-------------------|
| Arsenic: 1,110 mg/kg | Cadmium: 7 mg/kg  |
| Cobalt: 52.6 mg/kg   | Copper: 525 mg/kg |
| Mercury: 0.221 mg/kg | Lead: 1,660 mg/kg |
| Antimony: 23J mg/kg  | Zinc: 1,090 mg/kg |
- One discharging adit was identified at the site. No MCLs were exceeded in the adit discharge; however, acute and chronic aquatic life criteria for copper and zinc were exceeded. The chronic aquatic life criteria for lead was also exceeded. The adit discharge pH measurement was 7.75.
- No surface water was observed on or near the site. The nearest surface water was located approximately 600 feet away. No surface water or sediment samples were collected due to a lack of a direct runoff route.
- Two potentially hazardous open adits were identified at the site.

**SE SE Section 25 PA# 29-394**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 09/20/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 29-394-WR-1 | 1110       | 109        | 7          | 52.6       | 46.5       | 525        | 59400      | 0.221      | 1700 J     | 61.3       | 1660       | 23 J       | 1090       | NR              |
| BACKGROUND  | 10         | 129        | 0.6 U      | 16.6       | 57.6       | 28.4       | 21600      | 0.029      | 951 J      | 51         | 23         | 7 U        | 54         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 29-394-WR-1 | 0.2            | 6.25                           | 2.89                    | -3.4                             | 0.14             | <0.01            | 0.07             | 0                                | 2.89                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co  | Cr     | Cu   | Fe      | Hg     | Mn      | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|--------|-----|--------|------|---------|--------|---------|--------|--------|--------|-----------------|----------------|
| 29-394-SW-1 | 32.9 J | 3.73 | 4.59 U | 5 U | 6.24 U | 13.1 | 20.3 JX | 0.12 U | 3.76 UJ | 10.9 U | 2.78 J | 31.7 U | 59.9            | 35.9           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD<br>ID. | TOTAL<br>DISSOLVED<br>SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|--------------|------------------------------|----------|---------|-----------|---------|
| 29-394-SW-1  | 61                           | < 5      | 8       | 0.11      | NR      |

**LEGEND**

WR1 - Composite of subsamples WR1A, 1B, 1C, and 2.  
BACKGROUND - From the Missouri Mine (29-373-SS-1).

SW1 - Adit discharge at waste rock dump 2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: SE NW S24  
Legal Description: T 9N R 4E  
Mining District: Beaver Creek  
Latitude: N 46° 32' 10"  
Longitude: W 111° 10' 10"  
Land Status: Private  
Quad: Gipsy Lake  
Inspectors: Bullock, Clark/Pierson  
Organization: Pioneer Technical Services,  
Inc./ Thomas, Dean and Hoskins, Inc.

County: Meagher  
Section(s): SE 1/4, NW 1/4, Sec. 24  
Mine Type: Hardrock/Unknown  
Primary Drainage: Big Birch Creek  
USGS Code: 10030103  
Secondary Drainage: Gipsy Creek  
Date Investigated: July 28, 1993  
P.A. # 30-017

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be 395 cubic yards. The following elements were elevated at least three times background:

|                      |                     |
|----------------------|---------------------|
| Arsenic: 184J mg/kg  | Antimony: 108 mg/kg |
| Cadmium: 7.9JX mg/kg | Copper: 1240J mg/kg |
| Mercury: 2.25J mg/kg | Lead: 3910J mg/kg   |
| Zinc: 328J mg/kg     |                     |
- The waste rock dumps were unvegetated.
- No adit discharges, seeps or springs were observed.
- There was approximately one half mile of vegetated ground between the site and the nearest surface water.
- There were six open shafts present on the site that were classified as potentially hazardous. Several of the shafts have been used for household garbage disposal.



**SE NW Section 24 PA# 30-017**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/28/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 30-017-WR-1 | 184 J         | 226 J         | 7.9 JX        | 1.4 U         | 3.7 J         | 1240 J        | 9530          | 2.25 J        | 245 J         | 3 J           | 3910 J        | 108           | 328 J         | NR                 |
| BACKGROUND  | 24 J          | 116 J         | 0.8 UX        | 5.2 J         | 12.2 J        | 20.2 J        | 13400         | 0.032 J       | 361 J         | 7 J           | 19 J          | 10 U          | 39 J          | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 30-017-WR-1 | 0.04              | 1.25                                 | 2.49                          | 1.24                                      | 0.02                   | <0.01                  | 0.02                   | 0.00                                      | 2.49                                      |

**LEGEND**

WR1 - Composite of subsamples WR2 and 3.  
BACKGROUND - From the Lane Mine (30-019-SS-1)

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |  |
|--|--|
| Mine/Site Name: <u>Lane</u>  | County: <u>Meagher</u>                     |
| Legal Description: <u>T 9N R 4E</u>  | Section(s): <u>NW 1/4, SW 1/4, Sec. 13</u> |
| Mining District: <u>Beaver Creek</u>   | Mine Type: <u>Hardrock/Cu, Au</u>          |
| Latitude: <u>N 46° 32' 21"</u>   | Primary Drainage: <u>Big Birch Creek</u>   |
| Longitude: <u>W 111° 10' 40"</u>   | USGS Code: <u>10030103</u>                 |
| Land Status: <u>Private</u>  | Secondary Drainage: <u>Thompson Gulch</u>  |
| Quad: <u>Gipsy Lake</u>  | Date Investigated: <u>July 28, 1993</u>    |
| Inspectors: <u>Bullock, Clark/Pierson</u>  | P.A. # <u>30-019</u>                       |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |  |

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be 793 cubic yards. The following elements were elevated at least three times background:

|                       |                    |
|-----------------------|--------------------|
| Cadmium: 2.4JX mg/kg  | Copper: 164J mg/kg |
| Mercury: 0.729J mg/kg | Lead: 1110J mg/kg  |
| Zinc: 419 mg/kg       |                    |
- The waste rock dumps were mostly unvegetated.
- No adit discharges, seeps or springs were observed.
- There was approximately 150 feet of vegetated ground between the site and the nearest surface water.
- There was an open adit associated with WR-1 in the dry drainage, a hazardous pit associated with WR-2, and 2 open shafts associated with WR-3 and WR-4.

Lane PA# 30-019  
AMRB HAZARDOUS MATERIALS INVENTORY  
INVESTIGATOR: PIONEER - BULLOCK  
INVESTIGATION DATE: 07/28/93

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 30-019-WR-1 | 24 J          | 200 J         | 2.4 JX        | 4 J           | 4.6 J         | 164 J         | 11500         | 0.729 J       | 717 J         | 10 J          | 1110 J        | 21            | 419 J         | NR                 |
| BACKGROUND  | 24 J          | 116 J         | 0.8 UX        | 5.2 J         | 12.2 J        | 20.2 J        | 13400         | 0.032 J       | 361 J         | 7 J           | 19 J          | 10 U          | 39 J          | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL.<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|--------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 30-019-WR-1 | 0.01              | 0.31                                 | 4.63                           | 4.32                                      | <0.01                  | 0.01                   | <0.01                  | 0.31                                      | 4.32                                      |

**LEGEND**

WR1 - Composite of subsamples WR3 and 4.  
BACKGROUND - From the Lane (30-019-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |  |
|--|--|
| Mine/Site Name: <u>Bigler</u>  | County: <u>Meagher</u>                     |
| Legal Description: <u>T 9N R 4E</u>  | Section(s): <u>NE 1/4, SW 1/4, Sec. 28</u> |
| Mining District: <u>Beaver Creek</u>   | Mine Type: <u>Hardrock/Au, Ag, Cu</u>      |
| Latitude: <u>N 46° 15' 30"</u>   | Primary Drainage: <u>Thompson Gulch</u>    |
| Longitude: <u>W 111° 15' 30"</u>   | USGS Code: <u>10030103</u>                 |
| Land Status: <u>Public</u>   | Secondary Drainage: <u>Thompson Gulch</u>  |
| Quad: <u>Gipsy Lake</u>  | Date Investigated: <u>July 28, 1993</u>    |
| Inspectors: <u>Bullock, Clark/Pierson</u>  | P.A. # <u>30-067</u>                       |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |  |

- The volume of tailings associated with this site was estimated to be approximately 25 cubic yards. This was a very small volume of tailings in a secure impoundment. The following elements were elevated at least three times background:  
Cadmium: 2.4JX mg/kg                      Copper: 1020J mg/kg  
Iron: 66,400 mg/kg                      Nickel: 25 mg/kg
- The volume of waste rock associated with this site was estimated to be approximately 7500 cubic yards. Copper (262J mg/kg) was the only element elevated at least three times background.
- There were two adit discharges associated with this site. Neither discharge exceed any of the applicable MCLs or MCLGs. The acute aquatic life criteria for cadmium was exceeded in both adits. The pH of both discharges was greater than 8.5 and the specific conductance of both discharges is 160 umhos/cm. Both discharges returned to subsurface prior to discharging into the drainage approximately 1/3 mile below the site.



**Bigler PA# 30-067**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/28/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 30-067-TP-1 | 10 J          | 88.8 J        | 2.4 JX        | 11.7 J        | 13.7 J        | 1020 J        | 66400         | 0.05 J        | 987 J         | 25 J          | 42 J          | 7 U           | 52 J          | NR                 |
| 30-067-WR-1 | 5 J           | 60.7 J        | 0.9 JX        | 10.5 J        | 9.8 J         | 262 J         | 24900         | 0.029 J       | 634 J         | 11 J          | 31 J          | 5 U           | 50 J          | NR                 |
| BACKGROUND  | 24 J          | 116 J         | 0.8 UX        | 5.2 J         | 12.2 J        | 20.2 J        | 13400         | 0.032 J       | 361 J         | 7 J           | 19 J          | 10 U          | 39 J          | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID       | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL.<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|----------------|-------------------|--------------------------------------|--------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 30-067-TP-1    | 0.37              | 11.6                                 | 42.3                           | 30.7                                      | 0.37                   | <0.01                  | <0.01                  | 0.00                                      | 42.3                                      |
| 30-067-WR-1    | 0.07              | 2.19                                 | 10.5                           | 8.36                                      | 0.07                   | <0.01                  | <0.01                  | 0.00                                      | 10.5                                      |
| 30-067-WR-1DUP | 0.07              | 2.19                                 | 11.8                           | 9.62                                      | 0.07                   | <0.01                  | <0.01                  | 0.00                                      | 11.8                                      |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu     | Fe     | Hg    | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS<br>CALC. |
|-------------|--------|------|--------|-------|--------|--------|--------|-------|--------|--------|--------|--------|-----------------|-------------------|
| 30-067-GW-1 | 1.69 U | 2.27 | 2.57 U | 9.7 U | 6.83 U | 4.37 J | 34.4 J | 0.074 | 4.08 U | 12.7 U | 1.55 U | 30.7 U | 14.9 JX         | 61.4              |
| 30-067-GW-2 | 1.69 U | 3.3  | 2.57 U | 9.7 U | 6.83 U | 3.77 J | 20.7 J | 0.048 | 4.08 U | 12.7 U | 1.55 U | 30.7 U | 7.57 U)         | 61.8              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED<br>SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|---------------------------|----------|---------|-----------|---------|
| 30-067-GW-1 | 104                       | < 5.0    | 9       | 0.28      | NR      |
| 30-067-GW-2 | 103                       | < 5.0    | < 5.0   | 0.63      | NR      |

**LEGEND**

TP1 - Composite of subsamples TP1A and 1B.  
WR1 - Composite of subsamples WR1A, 1B, 2A, and 4A.  
BACKGROUND - From the Lane Mine (30-019-SS-1).  
WR1DUP - Duplicate of the 30-067-WR-1 sample.

GW1 - Adit #2 discharge.  
GW2 - Adit #3 discharge.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |   |
|--|---|
| Mine/Site Name: <u>Porcupine</u>   | County: <u>Meagher</u>                    |
| Legal Description: <u>T 9N R 4E</u>  | Section(s): <u>NW 1/4, NE 1/4, Sec.28</u> |
| Mining District: <u>Beaver Creek</u>   | Mine Type: <u>Hardrock/Au</u>             |
| Latitude: <u>N 40° 31' 05"</u>   | Primary Drainage: <u>Smith River</u>      |
| Longitude: <u>W 111° 13' 44"</u>   | USGS Code: <u>10030103</u>                |
| Land Status: <u>Public</u>   | Secondary Drainage: <u>Thompson Gulch</u> |
| Quad: <u>Gipsy Lake</u>  | Date Investigated: <u>July 28, 1993</u>   |
| Inspectors: <u>Bullock, Clark/Pierson</u>  | P.A. # <u>30-069</u>                      |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |   |

- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 12,550 cubic yards. The following elements were elevated at least three times background:

|                       |                        |
|-----------------------|------------------------|
| Copper: 238J mg/kg    | Manganese: 1,150 mg/kg |
| Mercury: 0.218J mg/kg |                        |
- No flowing adits, seeps, or springs were observed at the site during the investigation; however, water ponded in an open stope was identified and sampled for field parameters. The sample was not submitted for laboratory analyses due to normal field parameters and lack of receptors in the area. The nearest intermittent stream was over 1/2 mile from the site.
- Two potentially hazardous mine openings were identified at the site including an open stope and a covered adit. Two potentially hazardous structures identified at the site include a 12 feet tall highwall and a collapsing compressor shed.

**Porcupine PA# 30-069**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/28/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 30-069-WR-1 | 4 U           | 134 J         | 0.4 UX        | 4.8 J         | 3 J           | 238 J         | 22200         | 0.218 J       | 454 J         | 2 U           | 15 J          | 5 U           | 26 J          | NR                 |
| 30-069-WR-2 | 4 U           | 178 J         | 0.6 JX        | 4.3 J         | 1.6 J         | 6.9 J         | 11500         | 0.015 J       | 1150 J        | 3 J           | 26 J          | 5 U           | 45 J          | NR                 |
| BACKGROUND  | 24 J          | 116 J         | 0.8 UX        | 5.2 J         | 12.2 J        | 20.2 J        | 13400         | 0.032 J       | 361 J         | 7 J           | 19 J          | 10 U          | 39 J          | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 30-069-WR-1 | 0.02              | 0.62                                 | 4.11                          | 3.48                                      | 0.02                   | <0.01                  | <0.01                  | 0.00                                      | 4.11                                      |
| 30-069-WR-2 | <0.01             | 0.00                                 | 5.27                          | 5.27                                      | <0.01                  | <0.01                  | <0.01                  | 0.00                                      | 5.27                                      |

**LEGEND**

WR1 - Composite of subsamples WR1A and 1B.  
WR2 - Composite of subsamples WR2A and 3A.  
BACKGROUND - From the Lane Mine (30-019-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Cumberland  
Legal Description: T 8N R 8E  
Mining District: Castle Mountain  
Latitude: N 46° 27' 08"  
Longitude: W 110° 40' 57"  
Land Status: Private  
Quad: Castle Town  
Inspectors: Babits, Flammang, Lasher  
Organization: Pioneer Technical Services, Inc.

County: Meagher  
Section(s): NE 1/4, SE 1/4, Sec. 14  
Mine Type: Hardrock/Pb, Ag  
Primary Drainage: Alabaugh Creek  
USGS Code: 10040201  
Secondary Drainage: Castle Creek  
Date Investigated: July 29, 1993  
P.A.# 30-004

- There were no mill tailings associated with this site.
- There was a small amount of slag at the site. The following were elevated at least 3 times background:
  - Arsenic: 861J mg/kg
  - Cadmium: 7.8JX mg/kg
  - Iron: 143,000 mg/kg
  - Manganese: 4,740J mg/kg
  - Lead: 25,900J mg/kg
  - Antimony: 36 mg/kg
  - Zinc: 13,000J mg/kg
- There were approximately 20,680 cubic yards of mostly uncovered waste rock on site. The following were elevated at least 3 times background:
  - Arsenic: 542J to 574J mg/kg
  - Cadmium: 7.2JX to 9.6JX mg/kg
  - Mercury: 0.191J to 0.196J mg/kg
  - Lead: 15,200J to 52,500J mg/kg
  - Antimony: 22 to 40 mg/kg
  - Zinc: 990J to 2,000J mg/kg
- There were no discharging adits at the site.
- Castle Creek flows 60 feet from the slag. Observed releases of manganese and lead to downstream surface water were documented. No MCL/MCLGs were exceeded, but the chronic fresh water aquatic life criteria for mercury and lead were exceeded in downstream surface water.
- There were two open shafts at the site (one had been fenced but the fence was down).



**Cumberland PA# 30-004**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/29/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 30-004-SE-1 | 37 J       | 136 J      | 1.9 JX     | 6.6 J      | 11.9 J     | 15.5 J     | 13300      | 0.083 J    | 924 J      | 11 J       | 409 J      | 7 U        | 108 J      | NR              |
| 30-004-SE-2 | 61 J       | 191 J      | 2 JX       | 7.2 J      | 21.5 J     | 28.7 J     | 19200      | 0.106 J    | 975 J      | 17 J       | 1130 J     | 10 U       | 265 J      | NR              |
| 30-004-SL-1 | 861 J      | 406 J      | 7.8 JX     | 6.2 J      | 11.6 J     | 298 J      | 143000     | 0.009 UJ   | 4740 J     | 3 J        | 25900 J    | 36         | 13000 J    | NR              |
| 30-004-WR-1 | 542 J      | 48.4 J     | 9.6 JX     | 3.4 J      | 13.1 J     | 133 J      | 22800      | 0.191 J    | 566 J      | 12 J       | 52500 J    | 40         | 990 J      | NR              |
| 30-004-WR-2 | 574 J      | 58.4 J     | 7.2 JX     | 2.1 U      | 9.6 J      | 160 J      | 34600      | 0.196 J    | 1480 J     | 5 J        | 15200 J    | 22         | 2000 J     | NR              |
| BACKGROUND  | 63         | 154 J      | 2.2        | 21.9 J     | 21.4       | 396 J      | 46600      | 0.062 J    | 878        | 21 J       | 52 J       | 6 U        | 135 J      | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 30-004-SL-1 | 1.62           | 50.6                           | 150                      | 99.0                             | <0.01            | <0.01            | 3.33             | 0.00                             | 150                              |
| 30-004-WR-1 | 0.21           | 6.56                           | 578                      | 572                              | <0.01            | 0.17             | 0.39             | 5.31                             | 573                              |
| 30-004-WR-2 | 2.02           | 63.1                           | 419                      | 356                              | <0.01            | 1.55             | 1.53             | 48.4                             | 370                              |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co    | Cr     | Cu     | Fe     | Hg    | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|------|--------|-------|--------|--------|--------|-------|--------|--------|--------|--------|-----------------|----------------|
| 30-004-SW-1 | 3.69 | 19   | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 60.1 J | 0.097 | 4.08 U | 12.7 U | 1.14 J | 30.7 U | 7.57 U          | 40.2           |
| 30-004-SW-2 | 3.77 | 24.8 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 178 J  | 0.11  | 16.1   | 12.7 U | 6.5 J  | 30.7 U | 7.57 U          | 53.1           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 30-004-SW-1 | 79                     | < 5.0    | 5       | < 0.05    | NR      |
| 30-004-SW-2 | 92                     | < 5.0    | < 5     | 0.08      | NR      |

**LEGEND**

SE1 - Upgradient (approx. 100' from site) in Castle Creek.  
SE2 - 50 feet downgradient of slag pile in Castle Creek.  
SL1 - Small waste rock pile near middle.  
WR1 - Composite of subsamples WR2A, 2B, 2C, 2D, 2E, and 2F.  
WR2 - Composite of subsamples WWR1A, 1B, 3, and 4.  
BACKGROUND - From the Belle of the Castles (30-007-SS-1).

SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Belle of the Castle</u>            | County: <u>Meagher</u>                            |
| Legal Description: <u>T 8N R 8E</u>                   | Section(s): <u>NE 1/4, SW 1/4, SW 1/4, Sec. 2</u> |
| Mining District: <u>Castle Mountain</u>               | Mine Type: <u>Hardrock/Pb, Cu, Fe, Ag</u>         |
| Latitude: <u>N 46° 28' 55"</u>                        | Primary Drainage: <u>Alabaugh Creek</u>           |
| Longitude: <u>W 110° 41' 32"</u>                      | USGS Code: <u>10040201</u>                        |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Hensley Creek</u>          |
| Quad: <u>Castle Town</u>                              | Date Investigated: <u>July 29, 1993</u>           |
| Inspectors: <u>July 29, 1993</u>                      | P.A. # <u>30-007</u>                              |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be 5,500 cubic yards. The following elements were elevated at least three times background:  
Copper: 1,810J to 2,210J mg/kg      Lead: 402 mg/kg
- One discharging adit was observed at the site during the investigation. The MCL and the acute and chronic aquatic life criteria for copper were exceeded in the adit discharge. The chronic aquatic life criteria for iron, mercury, and lead were also exceeded in the adit discharge.
- Hensley Creek was flowing through the site. An observed release to Hensley Creek was documented for copper in water and sediment samples. Acute and chronic aquatic life criteria were exceeded for copper in the downstream sample; these exceedances were attributable to the site.
- One potentially hazardous adit opening was observed at the site.

**Belle of the Castles PA# 30-007**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/29/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 30-007-SE-1 | 20 J       | 192 J      | 3.6 JX     | 20.4 J     | 12 J       | 55.9 J     | 24800      | 0.026 UJ   | 533 J      | 20 J       | 107 J      | 15 U       | 344 J      | NR              |
| 30-007-SE-2 | 69 J       | 860 J      | 4.1 UX     | 74.5 J     | 25.5 J     | 5510 J     | 90200      | 0.08 J     | 1220 J     | 20 J       | 105 J      | 48 U       | 265 J      | NR              |
| 30-007-SE-3 | 17 J       | 173 J      | 2 JX       | 22.7 J     | 10.6 J     | 248 J      | 40000      | 0.029 J    | 989 J      | 15 J       | 124 J      | 11 U       | 231 J      | NR              |
| 30-007-WR-1 | 61 J       | 238 J      | 2.6 JX     | 38.5 J     | 9.4 J      | 1810 J     | 45800      | 0.024 J    | 2100 J     | 16 J       | 402 J      | 7 U        | 145 J      | NR              |
| 30-007-WR-2 | 25 J       | 127 J      | 2.4 JX     | 28.8 J     | 20.7 J     | 2210 J     | 48400      | 0.101 J    | 375 J      | 18 J       | 35 J       | 5 U        | 46 J       | NR              |
| BACKGROUND  | 63         | 154 J      | 2.2        | 21.9 J     | 21.4       | 396 J      | 46600      | 0.062 J    | 878        | 21 J       | 52 J       | 6 U        | 135 J      | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE $\mu$ /1000t | NEUTRAL POTENT. $\mu$ /1000t | SULFUR ACID BASE POTENT. $\mu$ /1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE $\mu$ /1000t | SULFUR ACID BASE POTENT. $\mu$ /1000t |
|-------------|----------------|-------------------------------------|------------------------------|---------------------------------------|------------------|------------------|------------------|---------------------------------------|---------------------------------------|
| 30-007-WR-1 | 0.01           | 0.31                                | 8.39                         | 8.08                                  | 0.01             | <0.01            | 0.01             | 0.00                                  | 8.39                                  |
| 30-007-WR-2 | 0.10           | 3.12                                | 6.88                         | 3.76                                  | 0.07             | <0.01            | 0.03             | 0.00                                  | 6.88                                  |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co    | Cr     | Cu     | Fe      | Hg    | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO <sub>3</sub> /L) | HARDNESS CALC. |
|-------------|------|------|--------|-------|--------|--------|---------|-------|------|--------|--------|--------|------------------------------|----------------|
| 30-007-SW-1 | 2.5  | 33.9 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 46.2 J  | 0.12  | 5.6  | 12.7 U | 0.72 U | 30.7 U | 18.9                         | 11             |
| 30-007-SW-2 | 2.7  | 40.9 | 2.57 U | 9.7 U | 6.83 U | 42.2   | 171 J   | 0.072 | 10.5 | 12.7 U | 0.72 U | 30.7 U | 20.6                         | 11.8           |
| 30-007-SW-3 | 3.63 | 33.4 | 2.57 U | 9.7 U | 6.83 U | 3.6    | 55.4 J  | 0.063 | 5.6  | 12.7 U | 0.72 U | 30.7 U | 18.8                         | 14.2           |
| 30-007-SW-4 | 11.9 | 22.2 | 2.57 U | 13    | 6.83 U | 3320   | 18900 J | 0.11  | 384  | 14.4   | 9.28 J | 30.7 U | 51.9                         | 65.4           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD I.D.  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO <sub>3</sub> /NO <sub>2</sub> -N | CYANIDE |
|-------------|------------------------|----------|---------|-------------------------------------|---------|
| 30-007-SW-1 | 49                     | < 5.0    | 6       | < 0.05                              | NR      |
| 30-007-SW-2 | 48                     | < 5.0    | 7       | < 0.05                              | NR      |
| 30-007-SW-3 | 51                     | < 5.0    | 6       | < 0.05                              | NR      |
| 30-007-SW-4 | 150                    | < 5.0    | 50      | < 0.05                              | NR      |

**LEGEND**

SE1 - Upgradient of discharging adit in Hensley Creek.  
SE2 - Immediately downgradient of adit discharge in Hensley Creek.  
SE3 - Downgradient below confluence with unnamed tributary of Hensley Creek.  
WR1 - Composite of subsamples WR1A and 1B.  
WR2 - Composite of subsamples WR2A, 2B, 3A, 3B, and 3C.  
BACKGROUND - Approx. 100' NW of upper, 50' above road.  
From Belle of the Castles (30-007-S9-1).

SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.  
SW3 - Same as sample SE3.  
SW4 - Adit discharge of waste rock dump 1.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: SW NE S10  
Legal Description: T 11N R 7E  
Mining District: Smith River  
Latitude: N 46° 48' 01"  
Longitude: W 110° 49' 42"  
Land Status: Private/Public  
Quad: Charcoal Gulch  
Inspectors: Bullock, Clark/Pierson  
Organization: Pioneer Technical Services,  
Inc./Thomas, Dean and Hoskins, Inc.

County: Meagher  
Section(s): SW 1/4, NE 1/4, Sec. 10  
Mine Type: Hardrock/Unknown  
Primary Drainage: Newland Creek  
USGS Code: 10030103  
Secondary Drainage: Newland Creek  
Date Investigated: July 28, 1993  
P.A. # 30-078

- There were no mill tailings observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 10,000 cubic yards. The following elements were elevated at least three times background:

|                               |                            |
|-------------------------------|----------------------------|
| Arsenic: 57J mg/kg            | Lead: 757J to 3,640J mg/kg |
| Cadmium: 4.8JX to 6.6JX mg/kg | Antimony: 116 mg/kg        |
| Copper: 70.5J to 104J mg/kg   | Zinc: 512J mg/kg           |
| Mercury: 4.35J mg/kg          |                            |
- No discharging adits, seeps, or springs were observed at the site during the investigation. One shaft containing water was identified on site and was sampled for field parameters; two very small precipitation ponds located on the waste rock dumps were also sampled for field parameters. A residential well located downgradient from the site was sampled for laboratory analyses. No MCLs were exceeded in the well sample.
- A potentially hazardous flooded shaft (reportedly up to 100 feet deep) was identified at the site. Potential hazards observed on-site included a 40 feet tall highwall and two collapsing wooden cabins.



**SW NE Section 10 PA# 30-078**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/28/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 30-078-WR-1 | 23 J       | 40.1 J     | 4.8 JX     | 2.1 U      | 1.5 U      | 104 J      | 3640       | 4.35 J     | 0.9 U      | 3 U        | 3640 J     | 116        | 324 J      | NR              |
| 30-078-WR-2 | 57 J       | 177 J      | 6.6 JX     | 6.4 J      | 11.1 J     | 70.5 J     | 29600      | 4.35 J     | 195 J      | 23 J       | 757 J      | 12         | 512 J      | NR              |
| BACKGROUND  | 18 J       | 121 J      | 1.4 JX     | 8.1 J      | 9.2 J      | 19.3 J     | 24100      | 0.038 J    | 579 J      | 19 J       | 68 J       | 7 U        | 125 J      | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE $\mu$ /1000t | NEUTRAL. POTENT. $\mu$ /1000t | SULFUR ACID BASE POTENT. $\mu$ /1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE $\mu$ /1000t | SULFUR ACID BASE POTENT. $\mu$ /1000t |
|-------------|----------------|-------------------------------------|-------------------------------|---------------------------------------|------------------|------------------|------------------|---------------------------------------|---------------------------------------|
| 30-078-WR-1 | 0.86           | 26.9                                | -3.34                         | -30.2                                 | 0.43             | 0.03             | 0.40             | 0.94                                  | -4.27                                 |
| 30-078-WR-2 | 0.45           | 14.1                                | -0.95                         | -15.0                                 | 0.42             | <0.01            | 0.03             | 0.00                                  | -0.95                                 |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu     | Fe     | Hg    | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO <sub>3</sub> /L) | HARDNESS CALC. |
|-------------|--------|------|--------|-------|--------|--------|--------|-------|--------|--------|--------|--------|------------------------------|----------------|
| 30-078-GW-1 | 1.69 U | 81.8 | 2.57 U | 9.7 U | 6.83 U | 5.77 J | 45.9 J | 0.096 | 4.08 U | 12.7 U | 1.55 U | 30.7 U | 15.9 JX                      | 334            |
| 30-078-GW-2 | 3.21   | 90.7 | 2.57 U | 9.7 U | 6.83 U | 3.73   | 34.7 J | 0.13  | 4.08 U | 12.7 U | 1.01 J | 30.7 U | 7.9                          | 370            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO <sub>3</sub> /NO <sub>2</sub> -N | CYANIDE |
|-------------|------------------------|----------|---------|-------------------------------------|---------|
| 30-078-GW-1 | 387                    | < 5.0    | 87      | 0.15                                | NR      |
| 30-078-GW-2 | 374                    | < 5.0    | 90      | 0.16                                | NR      |

**LEGEND**

WR1 - Sample of the subsample WR1.  
 WR2 - Composite of subsamples WR2A, 2B, and 2C.  
 BACKGROUND - From the SW NE Sec. 10 (30-078-SS-1).

GW1 - Residential well in drainage below mine.  
 GW2 - QA/QC duplicate of 30-078-GW-1.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Cajun Queen No. 1</u>              | County: <u>Mineral</u>                    |
| Legal Description: <u>T 15N R 27W</u>                 | Section(s): <u>NE 1/4, SE 1/4, Sec. 7</u> |
| Mining District: <u>Cedar Creek</u>                   | Mine Type: <u>Hardrock/Au, Ag</u>         |
| Latitude: <u>N 47° 04' 25"</u>                        | Primary Drainage: <u>Cedar Creek</u>      |
| Longitude: <u>W 115° 03' 15"</u>                      | USGS Code: <u>17010204</u>                |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Mary Ann Gulch</u> |
| Quad: <u>Illinois Peak</u>                            | Date Investigated: <u>August 3, 1993</u>  |
| Inspectors: <u>Bullock, Flammang, Belanger,</u>       | P.A. # <u>31-049</u>                      |
| <u>Lasher, Clark</u>                                  |   |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- This site was reported to be active periodically by the claim owner.
- A small impoundment containing approximately eighty cubic yards of mill tailings was associated with this site. The tailings were generated by a mobile ball mill that was present on the site. The following elements were elevated at least three times background:

|                     |                      |
|---------------------|----------------------|
| Barium: 51.8 mg/kg  | Chromium: 3.75 mg/kg |
| Copper: 17.1J mg/kg | Lead: 110J mg/kg     |
| Zinc: 57.6 mg/kg    |                      |
- The volume of waste rock associated with this site was estimated to be 1150 cubic yards. The following elements were elevated at least three times background:

|                     |                       |
|---------------------|-----------------------|
| Barium: 54 mg/kg    | Cadmium: 1.7 mg/kg    |
| Copper: 16.9J mg/kg | Mercury: 0.071J mg/kg |
| Lead: 88J mg/kg     | Zinc: 102 mg/kg       |
- No discharging adits, seeps or springs were found at the site.
- Approximately ten feet separated an old mostly vegetated waste rock pile (WR-4) and an unnamed tributary to Mary Ann Gulch. No laboratory samples were collected due to normal field parameter measurements, and lack of defined runoff pathways to the stream.
- There was an open adit below the Cajun Queen Mine in the Mary Ann Gulch drainage. One old cabin present on the site was classified as potentially hazardous. Highwalls were associated with WR-1 and WR-3.

**Cajun Queen No. 1 PA# 31-049**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/03/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 31-049-TP-1 | 4.58 U        | 51.8          | 0.7           | 2.1           | 3.75          | 17.1 J        | 4980          | 0.01 UJ       | 212           | 3.74          | 110 J         | 5.96 U        | 57.6          | NR                 |
| 31-049-WR-1 | 5.1 U         | 54            | 1.7           | 3.2           | 1.86          | 16.9 J        | 8050          | 0.072 J       | 435           | 3.89          | 88 J          | 6.64 U        | 102           | NR                 |
| BACKGROUND  | 7.89          | 8.8           | 0.5 U         | 3.31          | 1.2 U         | 2.44 J        | 3120          | 0.01 UJ       | 609           | 2.22 U        | 7.59 J        | 5.39 U        | 11.9          | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL.<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|----------------------|---|--------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 31-049-TP-1 | 0.01                 | 0.31                                    | 6.64                           | 6.33                                      | 0.01                   | <0.01                  | 0.01                   | 0.00                                      | 6.64                                      |
| 31-049-WR-1 | 0.01                 | 0.31                                    | 16.3                           | 16.0                                      | <0.01                  | <0.01                  | 0.01                   | 0.00                                      | 16.3                                      |

**LEGEND**

TP1 - Composite of subsamples TP1A and 1B.  
WR1 - Composite of subsamples WR1, 2, 3, and 4.  
BACKGROUND - From the Nancy Lee Mine  
(31-001-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Iron Mountain Millsite</u>         | County: <u>Mineral</u>                        |
| Legal Description: <u>T 17N R 26W</u>                 | Section(s): <u>NE 1/4, NW 1/4, Sec. 13</u>    |
| Mining District: <u>Iron Mountain</u>                 | Mine Type: <u>Millsite/Cu, Pb, Au, Ag, Zn</u> |
| Latitude: <u>N 47° 14' 25"</u>                        | Primary Drainage: <u>Clark Fork River</u>     |
| Longitude: <u>W 114° 51' 10"</u>                      | USGS Code: <u>17010204</u>                    |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Flat Creek</u>         |
| Quad: <u>Idaho Gulch</u>                              | Date Investigated: <u>July 22, 1993</u>       |
| Inspectors: <u>Tuesday, Belanger, Clark</u>           | P.A. # <u>31-010</u>                          |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- The volume of tailings associated with the site was estimated to be approximately 368 cubic yards for the upper two tailings piles. Tailings were observed in the Flat Creek floodplain for approximately three miles downstream. The following elements were elevated at least three times background:

|                              |                                 |
|------------------------------|---------------------------------|
| Arsenic: 1470 to 2120 mg/kg  | Cadmium: 43.3 to 210 mg/kg      |
| Copper: 68 to 319 mg/kg      | Iron: 54,000 mg/kg              |
| Mercury: 6.66 to 32.6 mg/kg  | Manganese: 2010J to 2080J mg/kg |
| Lead: 12,700 to 13,500 mg/kg | Antimony: 2390 to 3970 mg/kg    |
| Zinc: 8990 to 44,600 mg/kg   |                                 |
  
- The volume of waste rock associated with the site was estimated to be approximately 6,500 cubic yards. The following elements were elevated at least three times background:

|                        |                      |
|------------------------|----------------------|
| Arsenic: 82 mg/kg      | Mercury: 0.498 mg/kg |
| Manganese: 2780J mg/kg | Lead: 152 mg/kg      |
| Antimony: 28 mg/kg     | Zinc: 787 mg/kg      |
  
- There was one adit discharge observed at the site during the investigation. The MCL for arsenic was exceeded in the adit discharge, and the chronic aquatic life criteria for iron and zinc were exceeded. The acute aquatic life criteria for zinc was also exceeded in the adit discharge sample. No MCLs were exceeded in Flat Creek; however, the acute and chronic aquatic life criteria for zinc were exceeded in the downstream sample, which was directly attributed to the site.
  
- Flat Creek flowed southwest through the tailings to its confluence with the Clark Fork River approximately 3.5 miles downstream. An observed release to Flat Creek was documented for zinc. Additionally, significant increases in the concentrations of most metals were observed in the downstream Flat Creek sediments (when compared with the upstream sediment concentrations) which was directly attributed to the site. Observed releases to Hall Gulch (sediment) were documented for arsenic, cadmium, mercury, manganese, lead, antimony, and zinc.



**Iron Mountain Mill PA# 31-010**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 07/22/93**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 31-010-SE-1 | 428        | 46.4       | 27.5       | 5.5        | 1.6 U      | 51.3       | 32100      | 7.46       | 1800 J     | 7          | 7270       | 353        | 6240       | NR              |
| 31-010-SE-2 | 15         | 58.7       | 0.5 U      | 3.9        | 1.5 U      | 8.6        | 12400      | 0.014 U    | 312 J      | 6          | 48         | 7 U        | 116        | NR              |
| 31-010-SE-3 | 231        | 191        | 3.3        | 24.1       | 3.8        | 25.5       | 20300      | 0.652      | 3950 J     | 65         | 730        | 46         | 4110       | NR              |
| 31-010-SE-4 | 18         | 49.1       | 0.5 U      | 6.9        | 1.7        | 12.6       | 9730       | 0.057      | 231 J      | 6          | 92         | 6 U        | 122        | NR              |
| 31-010-TP-1 | 1470       | 5          | 210        | 2.8        | 5.4        | 319        | 36800      | 32.6       | 2080 J     | 3          | 13500      | 3970       | 44600      | NR              |
| 31-010-TP-2 | 2120       | 3.2        | 43.3       | 1.5 U      | 1 U        | 68         | 54000      | 6.66       | 2010 J     | 2 U        | 12700      | 2390       | 8990       | NR              |
| 31-010-WR-1 | 82         | 3.7        | 0.5 U      | 8.1        | 1.4 U      | 19.4       | 30600      | 0.498      | 2780 J     | 15         | 152        | 28         | 787        | NR              |
| BACKGROUND  | 13         | 257        | 0.5 U      | 8.5        | 2.7        | 15.5       | 17200      | 0.012 U    | 448 J      | 10         | 17         | 6 U        | 64         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 31-010-TP-1 | 2.53           | 79                             | 4.2                      | -75                              | 0.52             | 0.48             | 1.53             | 15                               | -10.8                            |
| 31-010-TP-2 | 1.52           | 47.5                           | 6.67                     | -41                              | 0.7              | 0.2              | 0.62             | 6.25                             | 0.42                             |
| 31-010-WR-1 | 0.11           | 3.44                           | 139                      | 136                              | <0.01            | 0.03             | 0.09             | 0.94                             | 138                              |

**WATER MATRIX ANALYSES**

**Metals in Water**  
**Results in ug/L**

| FIELD ID    | As   | Ba      | Cd     | Co    | Cr     | Cu     | Fe     | Hg      | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. Zn (mg CaCO3/L) |
|-------------|------|---------|--------|-------|--------|--------|--------|---------|--------|--------|--------|--------|-----------------|--------------------------------|
| 31-010-GW-1 | 302  | 38.4 JX | 2.57 U | 9.7 U | 6.83 U | 2.7 J  | 1620 J | 0.038 U | 4850   | 30.2   | 1.9 J  | 30.7 U | 3850 J          | 486                            |
| 31-010-SW-1 | 5.53 | 40.7 JX | 2.57 U | 9.7 U | 6.83 U | 2.63 J | 26.7 J | 0.038 U | 4.08 U | 12.7 U | 2.97 J | 30.7 U | 266 J           | 150                            |
| 31-010-SW-2 | 3.63 | 40.2 JX | 2.57 U | 9.7 U | 6.83 U | 1.57 J | 41.3 J | 0.038 U | 4.08 U | 12.7 U | 1.2 J  | 30.7 U | 7.57 U          | 138                            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Wet Chemistry**  
**Results in mg/l**

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 31-010-GW-1 | 612                    | < 5.0    | 183     | < 0.05    | NR      |
| 31-010-SW-1 | 195                    | < 5.0    | 8       | < 0.05    | NR      |
| 31-010-SW-2 | 203                    | < 5.0    | < 5.0   | 0.1       | NR      |

**LEGEND**

SE1 - Flat Creek below millsite.  
 SE2 - Flat Creek above millsite.  
 SE3 - Hall Gulch below waste rock dump 1.  
 SE4 - Hall Gulch above waste rock dump 1.  
 TP1 - Composite of subsamples TP1A1, 1A2, and 1B1.  
 TP2 - Composite of subsamples TP2A through 2E.  
 WR1 - Composite of subsamples WR1A through 1C.  
 BACKGROUND - From the Dillon Millsite (31-073-SS-1).

GW1 - Adit discharge into Hall Gulch.  
 SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Gold King</u>                      | County: <u>Mineral</u>                         |
| Legal Description: T <u>16N</u> R <u>24W</u>          | Section(s): <u>SE 1/4, SW 1/4, Sec. 20</u>     |
| Mining District: <u>Iron Mountain</u>                 | Mine Type: <u>Hardrock/Unknown</u>             |
| Latitude: <u>N 47° 07' 30"</u>                        | Primary Drainage: <u>South Fork Deep Creek</u> |
| Longitude: <u>W 114° 39' 45"</u>                      | USGS Code: <u>17010204</u>                     |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Malley Gulch</u>        |
| Quad: <u>Tarkio</u>                                   | Date Investigated: <u>August 2, 1993</u>       |
| Inspectors: <u>Bullock, Flammang, Clark</u>           | P.A. # <u>31-067</u>                           |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 400 cubic yards. The following elements were elevated at least three times background:  
Barium: 2,440 mg/kg                      Mercury: 0.715 mg/kg
- No discharging adits, filled shafts, seeps, or streams were observed at the site during the investigation and no other surface water was observed on or adjacent to the site; consequently, no groundwater or surface water samples were collected. Intermittent Malley Gulch was identified approximately 800 feet downgradient from the site; however, no direct runoff migration path to Malley Gulch was observed.
- One potentially hazardous open adit was identified at the site.

Golg King PA# 31-067  
AMRB HAZARDOUS MATERIALS INVENTORY  
INVESTIGATOR: PIONEER - BULLOCK  
INVESTIGATION DATE: 08/02/93

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 31-067-WR-1 | 4.79 U        | 2440          | 0.52 U        | 2.74          | 1.39 U        | 26.1          | 19200         | 0.715         | 515           | 7.86          | 8.21 U        | 6.23 U        | 6.52          | NR                 |
| BACKGROUND  | 13            | 257           | 0.5 U         | 8.5           | 2.7           | 15.5          | 17200         | 0.012 U       | 448 J         | 10            | 17            | 6 U           | 64            | NR                 |

U - Not Detected, J - Estimated Quantity, X - Outlier for Accuracy or Precision, NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL.<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|----------------------|---|--------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 31-067-WR-1 | 0.47                 | 14.7                                    | 7.24                           | -7.45                                     | 0.05                   | 0.05                   | 0.37                   | 1.56                                      | 5.67                                      |

**LEGEND**

WR1 - Composite of subsamples WR1A and 1B.  
BACKGROUND - From the Dillon Millsite (31-073-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Belle of the Hills</u>             | County: <u>Mineral</u>                    |
| Legal Description: <u>T 17N R 26W</u>                 | Section(s): <u>SW 1/4, SW 1/4, Sec. 1</u> |
| Mining District: <u>Iron Mountain</u>                 | Mine Type: <u>Hardrock/Pb, Zn, Ag</u>     |
| Latitude: <u>N 47° 15' 20"</u>                        | Primary Drainage: <u>Flat Creek</u>       |
| Longitude: <u>W 114° 51' 20"</u>                      | USGS Code: <u>17010204</u>                |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Hall Gulch</u>     |
| Quad: <u>Quinns Hot Springs</u>                       | Date Investigated: <u>July 22, 1993</u>   |
| Inspectors: <u>Tuesday, Belanger, Clark</u>           | P.A. # <u>31-072</u>                      |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no mill tailings observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 7,770 cubic yards. The following elements were elevated at least three times background:

|                              |                                 |
|------------------------------|---------------------------------|
| Arsenic: 244 to 1230 mg/kg   | Cadmium: 102 to 130 mg/kg       |
| Copper: 62 to 243 mg/kg      | Iron: 66,000 mg/kg              |
| Mercury: 7.8 to 47.7 mg/kg   | Manganese: 2330J to 5580J mg/kg |
| Lead: 10,700 to 40,300 mg/kg | Antimony: 785 to 3540 mg/kg     |
| Zinc: 1230 to 14,100 mg/kg   |                                 |
- There were no adit discharges, filled shafts, seeps, or springs observed at the site during the investigation; consequently, no groundwater or surface water samples were collected. Intermittent Hall Gulch, located approximately 400 feet below the site, appeared to be the nearest surface water drainage to the site.
- Four potentially hazardous mine openings, including three adits and one shaft, were observed at the site during the investigation.



**Belle of the Hills PA# 31-072**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 07/22/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 31-072-WR-1 | 1230          | 16.3          | 102           | 2.8           | 1.2 U         | 243           | 33400         | 47.7          | 2330 J        | 3             | 40300         | 3540          | 1230          | NR                 |
| 31-072-WR-2 | 244           | 6.7           | 130           | 2.8           | 1 U           | 62            | 66000         | 7.8           | 5580 J        | 3             | 10700         | 785           | 14100         | NR                 |
| BACKGROUND  | 13            | 257           | 0.5 U         | 8.5           | 2.7           | 15.5          | 17200         | 0.012 U       | 448 J         | 10            | 17            | 6 U           | 64            | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR ACID BASE<br>t/1000t | NEUTRAL. POTENT.<br>t/1000t | SULFUR ACID BASE<br>POTENT.<br>t/1000t | SULFATE SULFUR<br>% | PYRITIC SULFUR<br>% | ORGANIC SULFUR<br>% | PYRITIC SULFUR ACID BASE<br>t/1000t | SULFUR ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|-----------------------------------|-----------------------------|--|---------------------|---------------------|---------------------|-------------------------------------|--|
| 31-072-WR-2 | 0.64              | 20                                | 11.7                        | -8.3                                   | 0.14                | 0.13                | 0.37                | 4.06                                | 7.62                                   |
| 31-072-WR-1 | 0.23              | 7.19                              | 13.4                        | 6.23                                   | 0.17                | 0.02                | 0.04                | 0.62                                | 12.8                                   |

**LEGEND**

WR1 - Composite of subsamples WR1, 2, and 3.  
WR2 - Composite of subsamples WR4A, 5A, 4B, and 5B.  
BACKGROUND - From the Dillon Millsite (31-073-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Dillon Millsite</u>                | County: <u>Mineral</u>                     |
| Legal Description: <u>T 17N R 26W</u>                 | Section(s): <u>NW 1/4, NW 1/4, Sec. 12</u> |
| Mining District: <u>Iron Mountain</u>                 | Mine Type: <u>Millsite/Unknown</u>         |
| Latitude: <u>N 47° 15' 15"</u>                        | Primary Drainage: <u>Flat Creek</u>        |
| Longitude: <u>W 114° 51' 30"</u>                      | USGS Code: <u>17010204</u>                 |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Hall Gulch</u>      |
| Quad: <u>Plains</u>                                   | Date Investigated: <u>July 22, 1993</u>    |
| Inspectors: <u>Tuesday, Belanger, Clark</u>           | P.A. # <u>31-073</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no mill tailings observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 3,000 cubic yards. Waste rock was observed in the intermittent Hall Gulch stream bed for approximately 1/4 mile downstream. The following elements were elevated at least three times background:

|                        |                     |
|------------------------|---------------------|
| Arsenic: 863 mg/kg     | Cadmium: 14 mg/kg   |
| Copper: 67.9 mg/kg     | Mercury: 1.43 mg/kg |
| Manganese: 4670J mg/kg | Lead: 3970 mg/kg    |
| Antimony: 813 mg/kg    | Zinc: 7710 mg/kg    |
- There were no adit discharges, filled shafts, seeps, or springs observed at the site during the investigation; consequently, no groundwater or surface water samples were collected.
- Observed releases to Hall Gulch (sediment) were documented for arsenic, cadmium, antimony, and zinc, and were directly attributed to the site.
- WR-1, which was cut by Hall Gulch, was extremely steep and potentially hazardous.

**Dillon Millsite PA# 31-073**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 07/22/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 31-073-SE-1 | 41            | 190           | 0.7 U         | 6.1           | 2.9           | 17.2          | 24800         | 0.813         | 1040 J        | 8             | 395           | 9 U           | 275           | NR                 |
| 31-073-SE-2 | 396           | 38.3          | 6.5           | 8.4           | 1.5           | 22.4          | 22300         | 0.399         | 1480 J        | 19            | 498           | 45            | 3380          | NR                 |
| 31-073-WR-1 | 863           | 155           | 14            | 7.4           | 2.6           | 67.9          | 35300         | 1.43          | 4670 J        | 12            | 3970          | 813           | 7710          | NR                 |
| BACKGROUND  | 13            | 257           | 0.5 U         | 8.5           | 2.7           | 15.5          | 17200         | 0.012 U       | 448 J         | 10            | 17            | 6 U           | 64            | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 31-073-WR-1 | 0.48              | 15                                   | 131                           | 116                                       | 0.07                   | 0.21                   | 0.2                    | 6.56                                      | 124                                       |

**LEGEND**

SE1 - Upstream in Hall Gulch.  
SE2 - Downstream in Hall Gulch.  
WR1 - Composite of subsamples WR1A through 1C.  
BACKGROUND - Northwest of site along road,  
From Dillon Millsite (31-073-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Nancy Lee Mine</u>                 | County: <u>Mineral</u>                     |
| Legal Description: <u>T 18N R 26W</u>                 | Section(s): <u>SW 1/4, SE 1/4, Sec. 31</u> |
| Mining District: <u>Keystone</u>                      | Mine Type: <u>Hardrock/Au, Pb, Zn</u>      |
| Latitude: <u>N 47° 16' 12"</u>                        | Primary Drainage: <u>Clark Fork River</u>  |
| Longitude: <u>W 114° 57' 12"</u>                      | USGS Code: <u>17010204</u>                 |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Keystone Creek</u>  |
| Quad: <u>Keystone Peak</u>                            | Date Investigated: <u>August 2, 1993</u>   |
| Inspectors: <u>Tuesday, Belanger, Lasher</u>          | P.A. # <u>31-001</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no mill tailings observed at this site during the investigation; however, tailings were observed in the stream bed approximately 3,000 feet downstream from the site.
- The volume of waste rock associated with this site was estimated to be approximately 30,875 cubic yards. The following elements were elevated at least three times background :

|                              |                               |
|------------------------------|-------------------------------|
| Arsenic: 143 to 445 mg/kg    | Barium: 62.8 mg/kg            |
| Copper: 55.4J to 161J mg/kg  | Iron: 19,800 to 30,000 mg/kg  |
| Mercury: 0.058J mg/kg        | Manganese: 2050 to 2290 mg/kg |
| Nickel: 9.12 mg/kg           | Lead: 266J to 340J mg/kg      |
| Antimony: 27.1 to 46.2 mg/kg | Zinc: 184 to 324 mg/kg        |
- The water discharged from the adit associated with WR-4 exceeded the MCL and acute aquatic life criteria for arsenic and the chronic aquatic life criteria for arsenic and iron in samples collected near its mouth. After flowing through WR-4, the discharge exceeded the MCL for arsenic as well the chronic aquatic life criteria for arsenic and iron and the acute aquatic life criteria for iron.
- Two tunnels associated with the site, the Elander Tunnel and the Fawcett Tunnel, were fenced at the time of the investigation, but were open and potentially hazardous.



**Nancy Lee Mine PA# 31-001**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 08/02/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 31-001-WR-1 | 445        | 4.95       | 0.5 U      | 2.55       | 1.41 U     | 60.3 J     | 27100      | 0.008 UJ   | 920        | 2.62 U     | 340 J      | 46.2       | 22.5       | NR              |
| 31-001-WR-2 | 143        | 12         | 0.4 U      | 4.34       | 2.27       | 55.4 J     | 19800      | 0.015 J    | 2050       | 2.11 U     | 266 J      | 7.7        | 324        | NR              |
| 31-001-WR-3 | 143        | 62.8       | 0.5 U      | 8.73       | 2.01       | 161 J      | 30000      | 0.059 J    | 2290       | 9.12       | 279 J      | 27.1       | 184        | NR              |
| BACKGROUND  | 7.89       | 8.8        | 0.5 U      | 3.31       | 1.2 U      | 2.44 J     | 3120       | 0.01 UJ    | 609        | 2.22 U     | 7.59 J     | 5.39 U     | 11.9       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID       | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|----------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 31-001-WR-1    | 0.28           | 8.75                           | 0.90                    | -7.84                            | 0.21             | 0.02             | 0.05             | 0.62                             | 0.28                             |
| 31-001-WR-2    | 0.55           | 1.56                           | 4.97                    | 3.41                             | 0.01             | 0.01             | 0.03             | 0.31                             | 4.66                             |
| 31-001-WR-3    |                |                                |                         |                                  |                  |                  |                  |                                  |                                  |
| 31-001-WR-1DUP | 0.29           | 9.06                           | 1.15                    | -7.90                            | 0.23             | 0.02             | 0.040            | 0.62                             | 0.53                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As  | Ba   | Cd     | Co    | Cr   | Cu     | Fe    | Hg      | Mn   | Ni   | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|-----|------|--------|-------|------|--------|-------|---------|------|------|--------|--------|-----------------|----------------|
| 31-001-SW-1 | 815 | 40.5 | 2.57 U | 9.7 U | 8.2  | 1.55 U | 33900 | 0.038 U | 8160 | 15.3 | 1.55 U | 30.7 U | 7.57 U          | 530            |
| 31-001-SW-2 | 274 | 28   | 2.57 U | 9.7 U | 14.6 | 1.55 U | 13200 | 0.038 U | 7300 | 27   | 1.55 U | 30.7 U | 7.57 U          | 540            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 31-001-SW-1 | 694                    | 16.0     | 213     | < 0.05    | NR      |
| 31-001-SW-2 | 684                    | 5.7      | 214     | < 0.05    | NR      |

**LEGEND**

WR1 - Composite of subsamples WR1A, 1B, and 1C.

WR2 - Composite of subsamples WR2A, 2B, and 3.

WR3 - Composite of subsamples WR4A, 4B, and 4C.

BACKGROUND - West of waste rock dump 1 on divide near road.

SW1 - Discharge from adit above waste rock dump 4.

SW2 - Discharge from adit which flows through waste rock dump 4, taken below dump.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Keystone</u>                       | County: <u>Mineral</u>                     |
| Legal Description: T <u>18N</u> R <u>26W</u>          | Section(s): <u>NE 1/4, SE 1/4, Sec. 32</u> |
| Mining District: <u>Keystone</u>                      | Mine Type: <u>Hardrock/Au, Ag</u>          |
| Latitude: <u>N 47° 16' 22"</u>                        | Primary Drainage: <u>Clark Fork River</u>  |
| Longitude: <u>W 114° 55' 40"</u>                      | USGS Code: <u>17010204</u>                 |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Keystone Creek</u>  |
| Quad: <u>Keystone Peak</u>                            | Date Investigated: <u>August 2, 1993</u>   |
| Inspectors: <u>Tuesday, Belanger, Lasher</u>          | P.A. # <u>31-074</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no mill tailings observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 9,500 cubic yards. The following elements were elevated at least three times background:

|                    |                     |
|--------------------|---------------------|
| Barium: 53.2 mg/kg | Copper: 84.9J mg/kg |
| Lead: 39.5J mg/kg  | Zinc: 37.5 mg/kg    |
- One minor adit discharge was observed at the site during the investigation. The water flowed from the open adit over the waste rock dump for a distance prior to disappearing into the dump. No MCLs/MCLGs were exceeded in the adit discharge sample; however, the chronic aquatic life criteria for iron was exceeded.
- The site was situated directly in an intermittent drainage adjacent to perennial Keystone Creek. The drainage was dry at the time of the investigation.
- At the time of the site investigation, it appeared that the site had recently been mowed.
- Although the open adit had a gate with a lock, the wooden gate was in relatively poor condition, and the opening was potentially hazardous.

**Keystone PA# 31-074**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 08/02/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 31-074-WR-1 | 4.75 U     | 53.2       | 0.5 U      | 2.9        | 1.38 U     | 84.9 J     | 7490       | 0.01 UJ    | 1180       | 2.55 U     | 39.5 J     | 6.19 U     | 37.5       | NR              |
| BACKGROUND  | 7.89       | 8.8        | 0.5 U      | 3.31       | 1.2 U      | 2.44 J     | 3120       | 0.01 UJ    | 609        | 2.22 U     | 7.59 J     | 5.39 U     | 11.9       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu     | Fe   | Hg     | Mn  | Ni | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|--------|-------|--------|--------|------|--------|-----|----|--------|--------|-----------------|----------------|
| 31-074-GW-1 | 1.69 U | 51.5 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 1010 | 0.15 J | 813 | 13 | 1.55 U | 30.7 U | 7.57 U          | 314            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID.   | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 31-074-GW-1 | 375                    | < 5.0    | 107     | < 0.05    | NR      |

**LEGEND**

WR1 - Composite of subsamples WR1A through 1C.  
BACKGROUND - From Nancy Lee Mine (31-001-SS-1).

GW1 - Discharge from adit.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Little Anaconda  
Legal Description: T 18N R 26W  
Mining District: Keystone  
Latitude: N 47° 16' 40"  
Longitude: W 114° 52' 35"  
Land Status: Private/Public  
Quad: Plains  
Inspectors: Tuesday, Belanger, Clark  
Organization: Pioneer Technical Services, Inc.

County: Mineral  
Section(s): SE 1/4, NW 1/4, Sec. 35  
Mine Type: Hardrock/Au, Zn, Pb, Cu  
Primary Drainage: Clark Fork River  
USGS Code: 17010204  
Secondary Drainage: Pardee Creek  
Date Investigated: July 23, 1993  
P.A. # 31-077

- There were no mill tailings observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 9,230 cubic yards. The following elements were elevated at least three times background:

|                       |                        |
|-----------------------|------------------------|
| Arsenic: 39 mg/kg     | Barium: 22.6J mg/kg    |
| Cadmium: 3.6 mg/kg    | Cobalt: 11.4J mg/kg    |
| Copper: 15.4J mg/kg   | Iron: 47,500 mg/kg     |
| Mercury: 0.633J mg/kg | Manganese: 7,050 mg/kg |
| Nickel: 12J mg/kg     | Lead: 2,720J mg/kg     |
- There was one adit discharge observed at the site during the investigation. The minor discharge flowed over WR-1 and combined with the drainage. No MCLs or acute or chronic aquatic life criteria were exceeded in the adit discharge sample.
- An unnamed intermittent tributary to Pardee Creek bisected the site directly through several of the waste rock dumps, the dumps were actively eroding into the drainage.



**Little Anaconda PA# 31-077**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 07/23/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 31-077-WR-1 | 39         | 22.6 J     | 3.6        | 11.4 J     | 2.1        | 15.4 J     | 47500      | 0.633 J    | 7050       | 12 J       | 2720 J     | 15 J       | 301 J      | NR              |
| BACKGROUND  | 7.89       | 8.8        | 0.5 U      | 3.31       | 1.2 U      | 2.44 J     | 3120       | 0.01 UJ    | 609        | 2.22 U     | 7.59 J     | 5.39 U     | 11.9       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 31-077-WR-1 | 0.11           | 3.44                           | 139                     | 135                              | <0.01            | 0.04             | 0.1              | 1.25                             | 137                              |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba      | Cd     | Co    | Cr    | Cu    | Fe     | Hg      | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|---------|--------|-------|-------|-------|--------|---------|------|--------|--------|--------|-----------------|----------------|
| 31-077-GW-1 | 6.39 | 2.01 UX | 2.57 U | 9.7 U | 9.2 J | 1.9 J | 55.9 J | 0.038 U | 11.3 | 12.7 U | 7.43 J | 30.7 U | 60.7 J          | 261            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in rr

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 31-077-GW-1 | 272                    | <        | 5.0     | 35        | 0.33    |
|             |                        |          |         |           | NR      |

**LEGEND**

WR1 - Composite of subsamples WR1A, 1B, 2A, and 2B.  
BACKGROUND - From the Nancy Lee Mine (31-001-SS-1).

GW1 - Discharge from lower adit.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Hopkins</u>                        | County: <u>Mineral</u>                     |
| Legal Description: T <u>18N</u> R <u>26W</u>          | Section(s): <u>SE 1/4, SE 1/4, Sec. 35</u> |
| Mining District: <u>Keystone</u>                      | Mine Type: <u>Hardrock/Unknown</u>         |
| Latitude: <u>N 47° 16' 10"</u>                        | Primary Drainage: <u>Clark Fork River</u>  |
| Longitude: <u>W 114° 51' 50"</u>                      | USGS Code: <u>17010204</u>                 |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Pardee Creek</u>    |
| Quad: <u>Quinns Hot Springs</u>                       | Date Investigated: <u>July 23, 1993</u>    |
| Inspectors: <u>Tuesday, Belanger, Clark</u>           | P.A. # <u>31-078</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no mill tailings observed at this site during the investigation.
- The volume of waste rock associated with the site was estimated to be approximately 400 cubic yards. The two waste rock dumps have both completely revegetated naturally. The following elements were elevated at least three times background level:

|                       |                    |
|-----------------------|--------------------|
| Barium: 39.5J mg/kg   | Cadmium: 4.5 mg/kg |
| Copper: 9J mg/kg      | Iron: 13,300 mg/kg |
| Mercury: 0.558J mg/kg | Lead: 469J mg/kg   |
| Zinc: 417J mg/kg      |                    |
- Pardee Creek bisected the site directly between the two waste rock dumps. There were no MCLs or acute or chronic aquatic life criteria exceeded in either the upstream or downstream surface water samples of Pardee Creek. However, observed releases to Pardee Creek were documented for barium, cadmium, copper, mercury, lead, and zinc based on analyses of upstream and downstream sediment samples.
- Two potentially hazardous and easily accessible mine openings (adits) were observed along the Pardee Creek Road. An old cabin located at the west end of the site was collapsing and potentially hazardous.

**Hopkins PA# 31-078**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 07/23/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 31-078-SE-1 | 34         | 209 J      | 5.3        | 10.8 J     | 10.9       | 40.1 J     | 17800      | 1.98 J     | 849        | 12 J       | 1600 J     | 17 U       | 1080 J     | NR              |
| 31-078-SE-2 | 14         | 22.4 J     | 0.7        | 3.2 J      | 3          | 8.9 J      | 14300      | 0.12 J     | 732        | 9 J        | 173 J      | 7 U        | 184 J      | NR              |
| 31-078-WR-1 | 18         | 39.5 J     | 4.5        | 4.4 J      | 2.6        | 9 J        | 13300      | 0.558 J    | 1130       | 6 J        | 469 J      | 6 U        | 417 J      | NR              |
| BACKGROUND  | 7.89       | 8.8        | 0.5 U      | 3.31       | 1.2 U      | 2.44 J     | 3120       | 0.01 UJ    | 609        | 2.22 U     | 7.59 J     | 5.39 U     | 11.9       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 31-078-WR-1 | 0.08           | 2.5                            | 130                      | 128                              | <0.01            | 0.05             | 0.04             | 1.56                             | 129                              |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba      | Cd     | Co    | Cr     | Cu     | Fe     | Hg      | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|---------|--------|-------|--------|--------|--------|---------|--------|--------|--------|--------|-----------------|----------------|
| 31-078-SW-1 | 2.88 | 4.87 JX | 2.57 U | 9.7 U | 6.83 U | 1.87 J | 36.5 J | 0.038 U | 4.08 U | 12.7 U | 3.49 J | 30.7 U | 7.57 U          | 200            |
| 31-078-SW-2 | 2.53 | 4.8 JX  | 2.57 U | 9.7 U | 6.83 U | 2.07 J | 38.9 J | 0.038 U | 4.08 U | 12.7 U | 0.72 U | 30.7 U | 7.57 U          | 193            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 31-078-SW-1 | 215                    | < 5.0    | 6       | 0.05      | NR      |
| 31-078-SW-2 | 209                    | < 5.0    | 6       | 0.05      | NR      |

**LEGEND**

SE1 - Downstream in Pardee Creek.  
SE2 - Upstream in Pardee Creek.  
WR1 - Composite of subsamples WR1A and 1B.  
BACKGROUND - From the Nancy Lee Mine (31-001-SS-1).

SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Nancy Lee Millsite  
Legal Description: T 17N R 26W  
Mining District: Keystone  
Latitude: N 47° 15' 55"  
Longitude: W 114° 56' 21"  
Land Status: Public  
Quad: Keystone Peak  
Inspectors: Tuesday, Belanger, Lasher  
Organization: Pioneer Technical Services, Inc.

County: Mineral  
Section(s): NE 1/4, NW 1/4, Sec. 5  
Mine Type: Millsite/Cu, Ag, Pb, Zn, Au  
Primary Drainage: Clark Fork River  
USGS Code: 17010204  
Secondary Drainage: Keystone Creek  
Date Investigated: August 2, 1993  
P.A. # 31-082

- The volume of tailings associated with this site was estimated to be approximately 16,333 cubic yards. The tailings were observed in the floodplain of an unnamed drainage for approximately one mile downstream to confluence with Keystone Creek; however, the tailings were not observed in the Keystone Creek drainage. The following elements were elevated at least three times background:

|                      |                       |
|----------------------|-----------------------|
| Arsenic: 540 mg/kg   | Barium: 27.6 mg/kg    |
| Cadmium: 14.4 mg/kg  | Cobalt: 15.9 mg/kg    |
| Copper: 4630J mg/kg  | Iron: 66,800 mg/kg    |
| Mercury: 1.19J mg/kg | Manganese: 5340 mg/kg |
| Lead: 10,500J mg/kg  | Antimony: 1230 mg/kg  |
| Zinc: 9350 mg/kg     |                       |
- The flow in the unnamed drainage which travelled directly through the site consisted of the adit discharge originating at the Nancy Lee Mine located upstream. The MCL for arsenic and the chronic aquatic life criteria for arsenic and iron were exceeded in the upstream sample of this discharge; however, only the chronic aquatic life criteria for lead was exceeded in the downstream sample, just prior to where the water seeped into the ground. The chronic aquatic life criteria exceedance for lead was directly attributable to the site.
- Observed releases to surface water were documented for copper, lead, and zinc which were directly attributable to the site.



Nancy Lee Millsite PA# 31-082  
AMRB HAZARDOUS MATERIALS INVENTORY  
INVESTIGATOR: PIONEER - TUESDAY  
INVESTIGATION DATE: 08/02/93

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 31-082-TP-1 | 540        | 27.6       | 14.4       | 15.9       | 2.58       | 4630 J     | 66800      | 1.19 J     | 5340       | 2.38 U     | 10500 J    | 1230       | 9350       | NR              |
| BACKGROUND  | 7.89       | 8.8        | 0.5 U      | 3.31       | 1.2 U      | 2.44 J     | 3120       | 0.01 UJ    | 609        | 2.22 U     | 7.59 J     | 5.39 U     | 11.9       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 31-082-TP-1 | 0.69           | 21.6                           | 5.80                    | -15.8                            | <0.01            | 0.06             | 0.70             | 1.87                             | 2.98                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co    | Cr     | Cu     | Fe    | Hg      | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|------|--------|-------|--------|--------|-------|---------|------|--------|--------|--------|-----------------|----------------|
| 31-082-SW-1 | 4.84 | 43.1 | 2.57 U | 9.7 U | 6.83 U | 15.7   | 34.8  | 0.054 J | 8.2  | 12.7 U | 18.7   | 30.7 U | 53.2            | 314            |
| 31-001-SW-2 | 274  | 28   | 2.57 U | 9.8 U | 14.6   | 1.55 U | 13200 | 0.038 U | 7300 | 27     | 1.55 U | 30.7 U | 7.57 U          | 540            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 31-082-SW-1 | 404                    | 5.7      | 120     | < 0.05    | NR      |
| 31-001-SW-2 | 684                    | 5.7      | 214     | < 0.05    | NR      |

**LEGEND**

TP1 - Composite of subsamples TP1A, 1BA through 1BC, 1C, and 1D.  
BACKGROUND - From the Nancy Lee Mine (31-001-SS-1).

SW1 - Middle of floodplain tailings just before water goes into ground.  
31-001-SW-2 - Upstream sample for this site from the Nancy Lee Mine.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Nancy Lee Millsite-Slowey  
Legal Description: T 17N R 27W  
Mining District: Keystone  
Latitude: N 47° 14' 19"  
Longitude: W 115° 00' 25"  
Land Status: Private  
Quad: Wilson Gulch  
Inspectors: Bullock, Tuesday  
Organization: Pioneer Technical Services, Inc.

County: Mineral  
Section(s): NW 1/4, Sec. 14  
Mine Type: Millsite/Au, Ag, Pb, Cu  
Primary Drainage: Clark Fork River  
USGS Code: 17010204  
Secondary Drainage: Slowey Gulch  
Date Investigated: September 7, 1993  
P.A. # 31-090

- There were approximately 205,000 cubic yards of tailings on site. The following elements were elevated at least three times background:

|                                 |                                 |
|---------------------------------|---------------------------------|
| Arsenic: 1,490J to 3,040J mg/kg | Cadmium: 9.3 to 14 mg/kg        |
| Cobalt: 24.9 to 26.9 mg/kg      | Chromium: 6.48 mg/kg            |
| Copper: 299 to 316 mg/kg        | Iron: 114,000 to 178,000 mg/kg  |
| Mercury: 0.085J to 1.06J mg/kg  | Manganese: 7,630 to 9,940 mg/kg |
| Lead: 1,080 to 2,320 mg/kg      | Antimony: 85.4J to 123J mg/kg   |
| Zinc: 2,180 to 3,440 mg/kg      |                                 |
- There was no waste rock on site.
- There was no surface water on site; no surface water samples were collected. The nearest surface water was the Clark Fork River, approximately 200 feet away. A dry drainage existed on site. Observed releases of arsenic, cadmium, cobalt, mercury, lead, antimony, and zinc were documented in downstream sediments, but no direct pathway to the Clark Fork River was identified.
- There were no hazardous openings on site. There were four potentially hazardous structures identified on site.

Nancy Lee-Slowey PA# 31-090  
AMRB HAZARDOUS MATERIALS INVENTORY  
INVESTIGATOR: PIONEER - BULLOCK  
INVESTIGATION DATE: 09/07/93

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 31-090-SE-1 | 1010 J        | 379           | 13.8          | 15.8          | 4.8           | 435           | 30400         | 2.38 J        | 1620          | 7.21          | 3360          | 78.6 J        | 4240 J        | NR                 |
| 31-090-SE-2 | 31.4 J        | 93.6          | 0.4 U         | 3.66          | 4.11          | 590           | 14100         | 0.028 U       | 906           | 6.03          | 35.4          | 5.13 UJ       | 69.9 J        | NR                 |
| 31-090-TP-1 | 1490 J        | 6.21          | 9.3           | 24.9          | 2.9           | 316           | 178000        | 0.086 J       | 9940          | 1.99 U        | 1080          | 85.4 J        | 2180 J        | NR                 |
| 31-090-TP-2 | 3040 J        | 22.3          | 14.0          | 26.9          | 6.48          | 299           | 114000        | 1.06 J        | 7630          | 2.36          | 2320          | 123 J         | 3440 J        | NR                 |
| BACKGROUND  | 7.89          | 8.8           | 0.5 U         | 3.31          | 1.2 U         | 2.44 J        | 3120          | 0.01 UJ       | 609           | 2.22 U        | 7.59 J        | 5.39 U        | 11.9          | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR ACID BASE<br>t/1000t | NEUTRAL. POTENT.<br>t/1000t | SULFUR ACID BASE<br>POTENT. t/1000t | SULFATE SULFUR<br>% | PYRITIC SULFUR<br>% | ORGANIC SULFUR<br>% | PYRITIC SULFUR ACID BASE<br>t/1000t | SULFUR ACID BASE<br>POTENT. t/1000t |
|-------------|-------------------|-----------------------------------|-----------------------------|-------------------------------------|---------------------|---------------------|---------------------|-------------------------------------|-------------------------------------|
| 31-090-TP-1 | 0.66              | 20.6                              | 9.15                        | -12                                 | <0.01               | 0.74                | 0.19                | 23.1                                | -14                                 |
| 31-090-TP-2 | 0.78              | 24.4                              | 9.07                        | -15                                 | 0.04                | 0.56                | 0.18                | 17.5                                | -8.42                               |

**LEGEND**

SE1 - Intermittent drainage between tailings and cabin.  
SE2 - Upgradient intermittent drainage.  
TP1 - Composite of subsamples TP1A, 1B, 1C, 2A, 2B, 3A, 3B, and 3C  
TP2 - Composite of subsamples TP1D, 2C, 3C, and 4C.  
BACKGROUND - From the Nancy Lee (31-001-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Saltese Consolidate  
Legal Description: T 19N R 30W  
Mining District: Packer Creek  
Latitude: N 47° 26' 10"  
Longitude: W 115° 25' 40"  
Land Status: Public  
Quad: Haugan  
Inspectors: Bullock, Flammang, Clark  
Organization: Pioneer Technical Services, Inc.

County: Mineral  
Section(s): SE 1/4, NW 1/4, Sec. 4  
Mine Type: Hardrock/Unknown  
Primary Drainage: St. Regis River  
USGS Code: 17010204  
Secondary Drainage: Timber Creek  
Date Investigated: August 2, 1993  
P.A. # 31-021

- There were no mill tailings observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 1,300 cubic yards. The following elements were elevated at least three times background:  
Mercury: 0.228J mg/kg
- One discharging adit was observed at the site during the investigation. No MCLs were exceeded in the adit discharge; however, chronic aquatic life criteria were exceeded for mercury and lead. The adit discharge was sampled farther downstream after flowing over the waste rock dump, the sample exceeded the chronic aquatic life criteria for mercury.
- A potentially hazardous highwall was identified behind Adit #1, and a cabin located east of the site was collapsing and potentially hazardous.



**Salteste Consolidate PA# 31-021**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/02/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 31-021-WR-1 | 4.17 U     | 41         | 0.5 U      | 2.2        | 1.31       | 12.8 J     | 5740       | 0.228 J    | 255        | 4.27       | 29.7 J     | 5.42 U     | 39.3       | NR              |
| BACKGROUND  | 4.52 U     | 241        | 0.5 U      | 6.09       | 4.83       | 16.2 J     | 12500      | 0.047 J    | 1020       | 9.02       | 22.2 J     | 5.89 U     | 59.3       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 31-021-WR-1 | <0.01          | 0.00                           | 3.14                     | 3.14                             | <0.01            | <0.01            | <0.01            | 0.00                             | 3.14                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu     | Fe   | Hg      | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|--------|-------|--------|--------|------|---------|--------|--------|--------|--------|-----------------|----------------|
| 31-021-GW-1 | 1.69 U | 2.83 | 2.57 U | 9.7 U | 7.2    | 1.55 U | 18.6 | 0.052 J | 4.08 U | 12.7 U | 3.07   | 30.7 U | 7.57 U          | 23             |
| 31-021-SW-1 | 1.69 U | 16.5 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 65   | 0.056 J | 11.2   | 12.7 U | 1.55 U | 30.7 U | 7.57 U          | 21.5           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD I.D.  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 31-021-GW-1 | 48                     | 6.2      | < 5.0   | < 0.05    | NR      |
| 31-021-SW-1 | 56                     | 5.2      | < 5.0   | < 0.05    | NR      |

**LEGEND**

WR1 - Composite of subsamples WR1A, 1B, and 2.

BACKGROUND - From the Salteste Consolidate Mine (31-021-SS-1).

GW1 - Approx. 10' from the mouth of adit #1 where it appears out of a vegetated area.

SW1 - Approx. 50' below lower adit - downgradient.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Tarbox-Mineral King  
Legal Description: T 20N R 31W  
Mining District: Packer Creek  
Latitude: N 47° 27' 05"  
Longitude: W 115° 29' 55"  
Land Status: Public  
Quad: Haugan  
Inspectors: Bullock, Flammang, Clark  
Organization: Pioneer Technical Services, Inc.

County: Mineral  
Section(s): SE 1/4, NE 1/4, Sec. 35  
Mine Type: Hardrock/Pb, Zn, Ag, Au  
Primary Drainage: St. Regis River  
USGS Code: 17010204  
Secondary Drainage: Packer Creek  
Date Investigated: August 2, 1993  
P.A. # 31-003

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be approximately 5300 cubic yards. The following elements were elevated at least three times background:

|                            |                             |
|----------------------------|-----------------------------|
| Arsenic: 244 to 4030 mg/kg | Cadmium: 45.8 mg/kg         |
| Copper: 209J mg/kg         | Iron: 142,000 mg/kg         |
| Manganese: 6570 mg/kg      | Lead: 158J to 10,100J mg/kg |
| Antimony: 279 mg/kg        | Zinc: 443 to 26,400 mg/kg   |
- There was one adit discharge associated with this site. The small flow of approximately five gpm seeps from the adit portal through rock, discharging at the base of the dump. At this discharge point, the pH is 6.39 and the specific conductance was 140 umhos/cm. The MCLs/MCLGs were not exceeded in this discharge. The acute aquatic life criteria for zinc was exceeded and the chronic aquatic life criteria for lead and zinc were exceeded. The discharge flowed through a small wetlands prior to discharge into a tributary to Packer Creek.
- The Packer Creek tributary flowed north to south through the site, bisecting the waste rock dumps associated with the adit and shaft. Observed releases were documented for iron, manganese, and zinc. No MCL/MCLGs were exceeded in the stream. The acute and chronic aquatic life criteria for zinc were exceeded and directly attributable to this site.
- The headframe of the shaft was a hazardous structure. The shaft was covered at the time of this investigation, but was accessible and potentially hazardous.

**Tarbox-Mineral King PA# 31-003**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/02/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 31-003-SE-1 | 1210       | 45.1       | 1.7        | 5.61       | 2.9        | 42.6 J     | 87000      | 0.009 UJ   | 9650       | 2.1 U      | 3060 J     | 5.08 U     | 2440       | NR              |
| 31-003-SE-2 | 17.3       | 31.9       | 0.6 U      | 3.43       | 1.47 U     | 8.12 J     | 21800      | 0.009 UJ   | 711        | 7.99       | 37.9 J     | 6.61 U     | 55.4       | NR              |
| 31-003-WR-1 | 4030       | 33.4       | 45.8       | 6.57       | 3.34       | 209 J      | 142000     | 0.308 J    | 6570       | 2.59 U     | 10100 J    | 279        | 26400      | NR              |
| 31-003-WR-2 | 244        | 26.9       | 1.1        | 6.53       | 2.55       | 18 J       | 18700      | 0.071 J    | 1180       | 8.63       | 158 J      | 4.16 U     | 443        | NR              |
| BACKGROUND  | 4.52 U     | 241 J      | 0.5 U      | 6.09 J     | 4.83       | 16.2 J     | 12500      | 0.047 J    | 1020 J     | 9.02       | 22.2 J     | 5.89 U     | 59.3 J     | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 31-003-WR-1 | 3.14           | 98.1                           | 3.19                    | -94.9                            | 0.01             | 0.83             | 2.30             | 25.9                             | -22.7                            |
| 31-003-WR-2 | 0.14           | 4.37                           | 14.2                    | 9.82                             | 0.01             | 0.04             | 0.09             | 1.25                             | 12.9                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu     | Fe   | Hg      | Mn  | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|--------|-------|--------|--------|------|---------|-----|--------|------|--------|-----------------|----------------|
| 31-003-GW-1 | 1.69 U | 16.2 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 594  | 0.038 U | 793 | 13.5   | 1.97 | 30.7 U | 307             | 57.5           |
| 31-003-SW-1 | 3.46   | 8.9  | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 378  | 0.039 J | 178 | 14.4   | 2.85 | 30.7 U | 256             | 27.2           |
| 31-003-SW-2 | 1.69 U | 6.37 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 53.4 | 0.049 J | 5.6 | 12.7 U | 1.86 | 30.7 U | 7.57 U          | 11.5           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 31-003-GW-1 | 99                     | < 5.0    | 22      | < 0.05    | NR      |
| 31-003-SW-1 | 55                     | 5.7      | 8       | < 0.05    | NR      |
| 31-003-SW-2 | 43                     | 5.7      | < 5     | < 0.05    | NR      |

**LEGEND**

SE1 - Downgradient of waste rock dump 1, approx. 30' below lower shaft dump.  
SE2 - Upgradient of waste rock dump 2 on South Fork of Creek.  
WR1 - Sample of the WR1A subsample.  
WR2 - Composite of subsamples WR1B, 1C, 2A, 2B, and 2C.  
BACKGROUND - From the Saltese Consolidate (31-021-SS-1).

GW1 - At seep below adit #1.  
SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Linton Mine and Millsite</u>       | County: <u>Missoula</u>                    |
| Legal Description: T <u>12N</u> R <u>15W</u>          | Section(s): <u>NW 1/4, NE 1/4, Sec. 30</u> |
| Mining District: <u>Unincorporated</u>                | Mine Type: <u>Hardrock/Pb, Ag</u>          |
| Latitude: <u>N 46° 46' 30"</u>                        | Primary Drainage: <u>Cramer Creek</u>      |
| Longitude: <u>W 113° 32' 36"</u>                      | USGS Code: <u>17010201</u>                 |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Cramer Creek</u>    |
| Quad: <u>Mineral Ridge</u>                            | Date Investigated: <u>July 1, 1993</u>     |
| Inspectors: <u>Bullock, Flammang, Clark</u>           | P.A. # <u>32-017</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- The volume of tailings associated with this site was estimated to be approximately 23,000 cubic yards. The tailings were severely eroded by Cramer Creek. The following elements were elevated at least three times background:

|                       |                         |
|-----------------------|-------------------------|
| Arsenic: 1090JX mg/kg | Manganese: 34,300 mg/kg |
| Barium: 7340 mg/kg    | Nickel: 151J mg/kg      |
| Cobalt: 43.1J mg/kg   | Lead: 210J mg/kg        |
| Copper: 105 mg/kg     | Mercury: 1.41 mg/kg     |
  
- The volume of waste rock associated with this site was estimated to be approximately 6,500 cubic yards. The following elements were elevated at least three times background:

|                            |                              |
|----------------------------|------------------------------|
| Arsenic: 136 mg/kg         | Manganese: 3,620J mg/kg      |
| Barium: 694JX mg/kg        | Lead: 4,890J to 14,100 mg/kg |
| Copper: 155 to 183JX mg/kg | Antimony: 28J to 34 mg/kg    |
| Mercury: 7.88 mg/kg        |                              |
  
- No discharging adits, filled shafts, seeps, or springs were observed at the site during the investigation.
  
- Cramer Creek was flowing east to west adjacent to the site on the south side. The tailings and one of the waste rock dumps (WR-4) were situated next to the creek and tailings were actively eroding into the stream. There was not an observed release to surface water documented in the water samples. No MCL/MCLGs or acute or chronic aquatic life criteria were exceeded in upstream or downstream surface water samples. Observed releases of arsenic, barium, cobalt, copper, mercury, manganese, and lead were documented in the stream sediment samples.
  
- Six potentially hazardous mine openings were identified at the site. The loadout structure located in the east-central section of the site was also potentially hazardous and the southern part of the tailings pile was severely undercut by Cramer Creek.



**Linton PA# 32-017**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/01/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 32-017-SE-1 | 168 J      | 2420 JX    | 0.5 U      | 14.8 JX    | 4.1        | 57.2 JX    | 6220       | 0.552 J    | 11400 J    | 15         | 5830       | 21         | 60 J       | NR              |
| 32-017-SE-2 | 6 U        | 87.7 JX    | 0.6 U      | 2.5 UJX    | 6.6        | 10.4 JX    | 8010       | 0.16 J     | 410 J      | 9          | 88         | 8 U        | 65 J       | NR              |
| 32-017-TP-1 | 1090 JX    | 7340       | 0.6 U      | 43.1 J     | 13.1 J     | 105        | 25900 J    | 1.41       | 34300 J    | 151 J      | 210 J      | 9 J        | 85 J       | NR              |
| 32-017-WR-1 | 30 JX      | 12.2       | 0.5 U      | 1.1 U      | 2.2 J      | 155        | 3970 J     | 7.88       | 711 J      | 6 J        | 4890 J     | 28 J       | 56 J       | NR              |
| 32-017-WR-4 | 136 J      | 694 JX     | 0.5 U      | 3.1 JX     | 1.7        | 183 JX     | 4690       | 0.04 J     | 3620 J     | 7          | 14100      | 34         | 36 J       | NR              |
| BACKGROUND  | 17 JX      | 95         | 0.5 U      | 1.9 J      | 5.4 J      | 17.6       | 8760 J     | 0.081      | 747 J      | 9 J        | 63 J       | 4 U        | 57 J       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 32-017-TP-1 | <0.01          | 0                              | 309                      | 309                              | <0.01            | <0.01            | 0.01             | 0                                | 309                              |
| 32-017-WR-1 | 0.01           | 0.31                           | 960                      | 960                              | 0.01             | <0.01            | <0.01            | 0                                | 960                              |
| 32-017-WR-4 | 0.03           | 0.94                           | 912                      | 911                              | 0.03             | <0.01            | <0.01            | 0                                | 912                              |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba      | Cd     | Co    | Cr     | Cu     | Fe   | Hg      | Mn     | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|---------|--------|-------|--------|--------|------|---------|--------|--------|------|--------|-----------------|----------------|
| 32-017-SW-1 | 5.11 J | 50 JX   | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 66.4 | 0.038 U | 4.9    | 12.7 U | 1.25 | 30.7 U | 7.57 U          | 213            |
| 32-017-SW-2 | 5.13 J | 52.1 JX | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 51.6 | 0.038 U | 4.08 U | 12.7 U | 1 U  | 30.7 U | 7.57 U          | 214            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 32-017-SW-1 | 237                    | 6.7      | 10      | 0.11      | NR      |
| 32-017-SW-2 | 242                    | 6.7      | 8       | 0.13      | NR      |

**LEGEND**

SE1 - Downstream Cramer Creek.  
SE2 - Upstream Cramer Creek.  
TP1 - Composite of subsamples TP1A-A, 1A-B, and 1B-A.  
WR1 - Composite of subsamples WR1A, 1B, 1C, 2A, 2B, and 2C.  
WR4 - Sample of the WR4 subsample.  
BACKGROUND - From the Linton Mine (32-017-SS-1).

SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Morse and Kennedy  
Legal Description: T 13N R 14W  
Mining District: Elk Creek  
Latitude: N 46° 23' 20"  
Longitude: W 113° 21' 20"  
Land Status: Public  
Quad: Bata Mountain  
Inspectors: Babits, Lasher/Pierson  
Organization: Pioneer Technical Services,  
Inc./ Thomas, Dean and Hoskins, Inc.

County: Missoula  
Section(s): N 1/2, Sec. 15  
Mine Type: Hardrock/Cu  
Primary Drainage: Elk Creek  
USGS Code: 17010203  
Secondary Drainage: North Fork of Elk Creek  
Date Investigated: July 1, 1993  
P.A. # 32-033

- There were no mill tailings associated with this site.
- There were approximately 65,700 cubic yards of uncovered waste rock at the site. The following were elevated at least 3 times background:  
Barium: 3,810JX mg/kg  
Mercury: 1.08J mg/kg  
Lead: 111 mg/kg
- There were no discharging adits at the site.
- There was no surface water on the site. The nearest surface water was 0.5 mile away.
- There were no hazardous openings at the site; but, there were highwalls associated with the pits.

**Morse & Kennedy PA# 32-033**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/01/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 32-033-WR-1 | 4 U           | 3810 JX       | 0.4 U         | 5.4 JX        | 18.5          | 10.8 JX       | 10400         | 0.051 J       | 290 J         | 11            | 7 U           | 6             | 11 J          | NR                 |
| 32-033-WR-2 | 12 J          | 166 JX        | 0.5 U         | 6 JX          | 5.6           | 29.6 JX       | 9160          | 1.08 J        | 815 J         | 11            | 111           | 13            | 64 J          | NR                 |
| BACKGROUND  | 5 U           | 322 JX        | 0.6 U         | 5.6 JX        | 10            | 10.4 JX       | 9450          | 0.071 J       | 640 J         | 8             | 9 U           | 7 U           | 30 J          | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL.<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|--------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 32-033-WR-1 | <0.01             | 0                                    | 29.7                           | 29.7                                      | <0.01                  | <0.01                  | <0.01                  | 0   | 29.7                                      |
| 32-033-WR-2 | <0.01             | 0                                    | 506                            | 506                                       | <0.01                  | <0.01                  | 0.01                   | 0   | 506                                       |

**LEGEND**

WR1 - Composite of subsamples WR1, 2, 3, and 4.

WR2 - Composite of subsamples WR5A and 5B.

BACKGROUND - From Morse and Kennedy Mine (32-033-SS-1)

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Joe Wallit Mine  
Legal Description: T 17N R 24W  
Mining District: Nine Mile  
Latitude: N 47° 15' 11"  
Longitude: W 114° 41' 11"  
Land Status: Public  
Quad: Knowles  
Inspectors: Babits, Lasher/Pierson  
Organization: Pioneer Technical Services, Inc.

County: Missoula  
Section(s): NW 1/4, NW 1/4, Sec. 8  
Mine Type: Hardrock/Unknown  
Primary Drainage: Nine Mile Creek  
USGS Code: 17010204  
Secondary Drainage: St. Louis Creek  
Date Investigated: July 2, 1993  
P.A. # 32-010

- There were no mill tailings associated with this site.
- There were approximately 68,300 cubic yards of uncovered waste rock on site. The following were elevated at least 3 times background:  
Arsenic: 31J mg/kg  
Copper: 338JX mg/kg
- There were no discharging adits at the site.
- The East Fork of St. Louis Creek flows through the waste rock dumps and St. Louis Creek flows adjacent to the waste rock dumps. There were observed releases of arsenic and copper in downstream sediment; there were no observed releases to downstream surface water. No MCL/MCLGs were exceeded, but the chronic fresh water aquatic life criteria for lead was exceeded in downstream surface water.
- There were no hazardous openings at the site, but there was a highwall at the pit.



**Joe Wallit PA# 32-010**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 07/02/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 32-010-SE-1 | 10 J       | 44.7 JX    | 0.5 U      | 5.3 JX     | 3.5        | 11.4 JX    | 15300      | 0.066 J    | 251 J      | 14         | 12         | 6          | 64 J       | NR              |
| 32-010-SE-2 | 32 J       | 49.5 JX    | 0.5 U      | 7.5 JX     | 2.1        | 739 JX     | 18100      | 0.062 J    | 1000 J     | 9          | 20         | 12         | 74 J       | NR              |
| 32-010-WR-1 | 31 J       | 64.6 JX    | 0.5 U      | 6.7 JX     | 2.3        | 338 JX     | 16000      | 0.137 J    | 807 J      | 9          | 98         | 13         | 136 J      | NR              |
| BACKGROUND  | 8 J        | 336 JX     | 0.9        | 5.9 JX     | 2.2 U      | 12.1 JX    | 8140       | 0.18 J     | 1730 J     | 8          | 41         | 10 U       | 57 J       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 32-010-WR-1 | 0.01           | 0.31                           | 56.7                     | 56.3                             | <0.01            | 0.02             | <0.01            | 0.62                             | 56                               |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba       | Cd     | Co    | Cr     | Cu     | Fe   | Hg    | Mn     | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|----------|--------|-------|--------|--------|------|-------|--------|--------|------|--------|-----------------|----------------|
| 32-010-SW-1 | 3.65 J | 4.8 JX   | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 12.3 | 0.120 | 4.08 U | 12.7 U | 1.5  | 30.7 U | 12.9            | 37.8           |
| 32-010-SW-2 | 3.7 J  | 2.01 UJX | 2.57 U | 9.7 U | 8.83   | 1.55 U | 19.7 | 0.160 | 4.08 U | 12.7 U | 3.43 | 30.7 U | 7.57 U          | 16.1           |
| 32-010-SW-3 | 3.82 J | 3.17 JX  | 2.57 U | 9.7 U | 6.83 U | 1.7 J  | 54   | 0.200 | 23.1   | 12.7 U | 1 U  | 30.7 U | 7.57 U          | 30.7           |
| 32-010-SW-4 | 3.01 J | 2.3 JX   | 2.57 U | 9.7 U | 6.83 U | 15 J   | 39.3 | 0.190 | 4.4    | 12.7 U | 2.88 | 30.7 U | 7.57 U          | 19.6           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 32-010-SW-1 | 77                     | < 5.0    | < 5     | < 0.05    | NR      |
| 32-010-SW-2 | 56                     | < 5.0    | < 5     | < 0.05    | NR      |
| 32-010-SW-3 | 61                     | < 5.0    | < 5     | < 0.05    | NR      |
| 32-010-SW-4 | 59                     | 6.7      | < 5     | < 0.05    | NR      |

**LEGEND**

SE1 - Upgradient in St. Louis Creek.

SE2 - Below confluence of East Fork St. Louis Creek in St. Louis Creek.

WR1 - Composite of subsamples WR1, 2, 3, and 4.

BACKGROUND - From the Joe Wallit Mine (32-010-SS-1).

SW1 - Same as sample SE1.

SW2 - Same as sample SE2.

SW3 - Downgradient of last dump in St. Louis Creek.

SW4 - Upgradient in East Fork of St. Louis Creek.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Lost Cabin Mine</u>                | County: <u>Missoula</u>                       |
| Legal Description: T <u>16N</u> R <u>22W</u>          | Section(s): <u>SE 1/4, NE 1/4, Sec. 13</u>    |
| Mining District: <u>Nine Mile</u>                     | Mine Type: <u>Hardrock/Zn, Pb, Cu, Ag, Au</u> |
| Latitude: <u>N 47° 08' 56"</u>                        | Primary Drainage: <u>Kennedy Creek</u>        |
| Longitude: <u>W 114° 26' 40"</u>                      | USGS Code: <u>17010204</u>                    |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Kennedy Creek</u>      |
| Quad: <u>McCormick Peak</u>                           | Date Investigated: <u>July 2, 1993</u>        |
| Inspectors: <u>Bullock, Flammang, Clark</u>           | P.A. # <u>32-011</u>                          |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- This site was in close proximity to the Hautilla Mine (PA# 32-057) and the Nugget Mine (PA# 32-042).
- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be 3700 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 98J mg/kg                      Copper: 1150JX mg/kg  
Mercury: 0.318J mg/kg                  Lead: 3370 mg/kg
- The waste rock dump was mostly unvegetated.
- No discharging adits, seeps and springs were found at the site.
- Surface water samples were collected upstream and downstream of the site in Kennedy Creek which bisected the site. There were no observed releases documented to surface water and the samples did not exceed MCL/MCLGs. Acute and chronic aquatic life criteria for copper were exceeded and attributable to this site. Stream sediment samples did document observed releases of copper, mercury, and lead, attributable to this site.
- The bridge on Kennedy Creek at the site posed a potential hazard to site visitors.

**Lost Cabin PA# 32-011**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/02/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 32-011-SE-1 | 26 J       | 43.6 JX    | 0.6 U      | 10.1 JX    | 5.4        | 177 JX     | 24300      | 0.199 J    | 548 J      | 16         | 346        | 7 U        | 293 J      | NR              |
| 32-057-SE-1 | 11 J       | 41.8 JX    | 0.6 U      | 6.1 JX     | 5.4        | 37.1 JX    | 15500      | 0.025 J    | 298 J      | 11         | 17         | 7 U        | 56 J       | NR              |
| 32-011-WR-1 | 98 J       | 17.2 JX    | 1.2        | 7.8 JX     | 4.3        | 1150 JX    | 21700      | 0.318 J    | 398 J      | 11         | 3370       | 8          | 478 J      | NR              |
| BACKGROUND  | 14 J       | 689 JX     | 0.8        | 7 JX       | 3.9        | 17.8 JX    | 13100      | 0.1 J      | 3380 J     | 16         | 43         | 6          | 329 J      | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 32-011-WR-1 | 0.21           | 6.56                           | 3.29                     | -3.3                             | 0.08             | 0.01             | 0.12             | 0.31                             | 2.98                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba      | Cd     | Co    | Cr     | Cu     | Fe   | Hg      | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|---------|--------|-------|--------|--------|------|---------|--------|--------|--------|--------|-----------------|----------------|
| 32-011-SW-1 | 1.49 U | 4.27 JX | 2.57 U | 9.7 U | 6.83 U | 7.73 J | 31   | 0.056 J | 4.08 U | 12.7 U | 2.24 J | 30.7 U | 37.7 J          | 23             |
| 32-057-SW-1 | 1.81   | 2.13 JX | 2.57 U | 9.7 U | 6.83 U | 2.63 J | 36.1 | 0.097 J | 4.08 U | 12.7 U | 1.29 J | 30.7 U | 19.9 J          | 20.3           |

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 32-011-SW-1 | 93                     | < 5.0    | < 5     | < 0.05    | NR      |
| 32-057-SW-1 | 49                     | < 5.0    | < 5     | < 0.05    | NR      |

**LEGEND**

32-011-SE1 - 20' below bridge, also below confluence of unnamed tributary.  
32-057-SE1 - Downgradient of Hautilla mine, upgradient for Lost Cabin.  
WR1 - Composite of subsamples WR1A, 1B, 1C, and 2.  
BACKGROUND - From the Lost Cabin Mine (32-001-SS-1).  
SW1 - Same as sample 32-011-SE-1.  
SW2 - Same as sample 32-057-SE-1.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Nugget</u>                         | County: <u>Missoula</u>                       |
| Legal Description: T <u>16N</u> R <u>23W</u>          | Section(s): <u>NW 1/4, SE 1/4, Sec. 13</u>    |
| Mining District: <u>Nine Mile</u>                     | Mine Type: <u>Hardrock/Au, Ag, Cu, Pb, Zn</u> |
| Latitude: <u>N 47° 08' 50"</u>                        | Primary Drainage: <u>Kennedy Creek</u>        |
| Longitude: <u>W 114° 26' 45"</u>                      | USGS Code: <u>17010204</u>                    |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Kennedy Creek</u>      |
| Quad: <u>McCormick Peak</u>                           | Date Investigated: <u>July 2, 1993</u>        |
| Inspectors: <u>Bullock, Flammang, Clark</u>           | P.A. # <u>32-042</u>                          |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be 1300 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 150J mg/kg                      Copper: 9378J mg/kg  
Lead: 2340 mg/kg
- The waste rock dumps were 75% unvegetated.
- One discharging adit had a small flow of approximately 1.3 gpm. The adit water was sampled as GW-1 and had a neutral pH of 7.09, and a moderate specific conductance of 108.6 umhos/cm. The adit discharge flowed into a small settling pond constructed in the waste rock prior to discharging directly to Kennedy Creek. No MCL/MCLGs were exceeded. Chronic aquatic life criteria were exceeded for mercury, copper, lead, and zinc, and the acute aquatic life criteria were exceeded for copper and zinc in the adit discharge.
- Surface water samples were collected upstream and downstream on Kennedy Creek which bisected the site. There were no observed releases to surface water documented and the samples did not exceed MCL/MCLGs. Acute and chronic aquatic life criteria were exceeded in Kennedy Creek but could not be attributed to this site due to upgradient sources (the Lost Cabin and Hautilla Mines). Stream sediment samples did document observed releases of copper and lead, attributable to this site.
- The discharging adit was open and hazardous. WR-1 was being undercut by Kennedy Creek.



**Nugget PA# 32-042**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/02/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 32-042-SE-1 | 32 J       | 17.6 JX    | 0.4 U      | 4.6 JX     | 2          | 642 JX     | 12400      | 0.015 J    | 238 J      | 7          | 227        | 5 U        | 301 J      | NR              |
| 32-011-SE-1 | 26 J       | 43.6 JX    | 0.6 U      | 10.1 JX    | 5.4        | 177 JX     | 24300      | 0.199 J    | 548 J      | 16         | 346        | 7 U        | 293 J      | NR              |
| 32-042-WR-1 | 150 J      | 10.1 JX    | 0.5 U      | 4 JX       | 1.3 U      | 378 JX     | 21600      | 0.196 J    | 143 J      | 9          | 2340       | 11         | 330 J      | NR              |
| BACKGROUND  | 14 J       | 689 JX     | 0.8        | 7 JX       | 3.9        | 17.8 JX    | 13100      | 0.1 J      | 3380 J     | 16         | 43         | 6          | 329 J      | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 32-042-WR-1 | 0.24           | 7.5                            | 3.65                    | -3.9                             | 0.19             | <0.01            | 0.06             | 0                                | 3.65                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba      | Cd     | Co    | Cr     | Cu     | Fe   | Hg      | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|---------|--------|-------|--------|--------|------|---------|--------|--------|--------|--------|-----------------|----------------|
| 32-042-GW-1 | 2.63   | 7.23 JX | 2.57 U | 9.7 U | 6.83 U | 38.6 J | 377  | 0.096 J | 88.1   | 12.7 U | 6.1 J  | 30.7 U | 1370 J          | 33             |
| 32-042-SW-1 | 1.49 U | 4.03 JX | 2.57 U | 9.7 U | 6.83 U | 6.7 J  | 25.8 | 0.071 J | 4.08 U | 12.7 U | 1.67 J | 30.7 U | 60.1 J          | 23.2           |
| 32-011-SW-1 | 1.49 U | 4.27 JX | 2.57 U | 9.7 U | 6.83 U | 7.73 J | 31   | 0.056 J | 4.08 U | 12.7 U | 2.24 J | 30.7 U | 37.7 J          | 23             |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD I.D.  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 32-042-GW-1 | 76                     | < 5.0    | 9       | < 0.05    | NR      |
| 32-042-SW-1 | 63                     | < 5.0    | < 5     | < 0.05    | NR      |
| 32-057-SW-1 | 49                     | < 5.0    | < 5     | < 0.05    | NR      |

**LEGEND**

32-042-SE1 - Downstream of site.

32-011-SE1 - 20' below bridge, below Lost Cabin Mine.

WR1 - Composite of subsamples WR1A, 1B, 1C, and 1D.

BACKGROUND - From the Lost Cabin Mine (32-011-SS-1).

GW1 - At mouth of adit #1.

32-042-SW1 - Same as corresponding SE1 sample.

32-011-SW1 - Same as corresponding SE1 sample.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Hautilla  
Legal Description: T 16N R 23W  
Mining District: Nine Mile  
Latitude: N 47° 09' 08"  
Longitude: W 114° 26' 30"  
Land Status: Public  
Quad: McCormick Peak  
Inspectors: Bullock, Flammang, Clark  
Organization: Pioneer Technical Services, Inc.

County: Missoula  
Section(s): NE 1/4, NE 1/4, Sec. 13  
Mine Type: Hardrock/Cu, Ag, Zn  
Primary Drainage: Kennedy Creek  
USGS Code: 17010204  
Secondary Drainage: Kennedy Creek  
Date Investigated: July 2, 1993  
P.A. # 32-057

- This site was directly downstream from the Lost Cabin (PA# 32-011) and Hautilla (PA#32-057) Mines.
- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be 3800 cubic yards. Copper (530JX mg/kg) was the only element elevated at least three times background.
- The waste rock dump was 50% vegetated.
- No discharging adits, seeps and springs were found at the site.
- Kennedy Creek flowed along the north side of the site. There were no observed releases to surface water or exceedances of MCL/MCLGs or aquatic life criteria. Copper was documented as an observed release in the stream sediment samples.
- A cabin present on site was classified as a potentially hazardous structure.

**Hautilla PA# 32-057**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/02/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 32-057-SE-1 | 11 J       | 41.8 JX    | 0.6 U      | 6.1 JX     | 5.4        | 37.1 JX    | 15500      | 0.025 J    | 298 J      | 11         | 17         | 7 U        | 56 J       | NR              |
| 32-057-SE-2 | 6 U        | 36.7 JX    | 0.6 U      | 4.2 JX     | 2.1        | 11 JX      | 13200      | 0.106 J    | 288 J      | 10         | 9 U        | 7 U        | 34 J       | NR              |
| 32-057-WR-1 | 24 J       | 42.4 JX    | 0.5 U      | 19.1 JX    | 1.3 U      | 530 JX     | 9180       | 0.056 J    | 577 J      | 14         | 34         | 6 U        | 122 J      | NR              |
| BACKGROUND  | 14 J       | 689 JX     | 0.8        | 7 JX       | 3.9        | 17.8 JX    | 13100      | 0.1 J      | 3380 J     | 16         | 43         | 6          | 329 J      | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 32-057-WR-1 | 0.02           | 0.62                           | 5.2                     | 4.57                             | <0.01            | <0.01            | 0.03             | 0                                | 5.2                              |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba      | Cd     | Co    | Cr     | Cu     | Fe   | Hg      | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|---------|--------|-------|--------|--------|------|---------|--------|--------|--------|--------|-----------------|----------------|
| 32-057-SW-1 | 1.81 | 2.13 JX | 2.57 U | 9.7 U | 6.83 U | 2.63 J | 36.1 | 0.097 J | 4.08 U | 12.7 U | 1.29 J | 30.7 U | 19.9 J          | 20.3           |
| 32-057-SW-2 | 2.25 | 3.87 JX | 2.57 U | 9.7 U | 6.83 U | 2.53 J | 41.3 | 0.190 J | 4.08 U | 12.7 U | 1.27 J | 30.7 U | 7.57 U          | 18.8           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 32-057-SW-1 | 49                     | < 5.0    | < 5     | < 0.05    | NR      |
| 32-057-SW-2 | 63                     | < 5.0    | < 5     | < 0.05    | NR      |

**LEGEND**

SE1 - Downgradient of site.

SE2 - Upgradient of site.

WR1 - Composite of subsamples WR1A, 1B, and 1C.

BACKGROUND - From the Lost Cabin Mine (32-011-SS-1).

SW1 - Same as sample SE1.

SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Ward Lode</u>                      | County: <u>Missoula</u>                        |
| Legal Description: T <u>11N</u> R <u>22W</u>          | Section(s): <u>NE 1/4, SE 1/4, Sec. 21</u>     |
| Mining District: <u>Woodman</u>                       | Mine Type: <u>Hardrock/Ag, Pb</u>              |
| Latitude: <u>N 46° 41' 42"</u>                        | Primary Drainage: <u>South Fork Lolo Creek</u> |
| Longitude: <u>W 114° 21' 40"</u>                      | USGS Code: <u>17010205</u>                     |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Dick Creek</u>          |
| Quad: <u>Dick Creek</u>                               | Date Investigated: <u>September 8, 1993</u>    |
| Inspectors: <u>Bullock, Tuesday</u>                   | P.A. # <u>32-005</u>                           |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 321,200 cubic yards. The following elements were elevated at least three times background:

|                              |                              |
|------------------------------|------------------------------|
| Arsenic: 68.3 to 89.8 mg/kg  | Cadmium: 2.5 to 12.1 mg/kg   |
| Chromium: 55.2 to 86.9 mg/kg | Copper: 70.5J to 77.9J mg/kg |
| Nickel: 55.5 to 79.1 mg/kg   | Lead: 588 to 590 mg/kg       |
| Zinc: 1990 to 7660 mg/kg     |                              |
- One possible adit discharge was observed at this site during the investigation. No MCLs were exceeded in the adit discharge; however, acute and chronic aquatic life criteria were exceeded for cadmium, copper, lead and zinc.
- A sediment sample was collected just below the settling basin associated with the adit discharge. Arsenic, lead, and zinc concentrations were significantly elevated (greater than three times background) in the sediment sample.
- Potential safety hazards identified at the site included a 50 feet tall highwall associated with the trench and an over-steepened waste rock dump (WR-1) which was actively eroding.



**Ward Lode Mine PA# 32-005**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER-BULLOCK**  
**INVESTIGATION DATE: 09/08/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | Cyanide<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 32-005-SE-1 | 39.2 J        | 190           | 1.8           | 3.47          | 7.24          | 11            | 5680          | 0.031 U       | 638           | 9.2           | 104           | 6.96 UJ       | 385 J         | NR                 |
| 32-005-WR-1 | 68.3          | 618 J         | 2.5           | 8.78 J        | 55.2          | 70.5 J        | 21900         | 0.061         | 1750 J        | 55.5          | 590           | 5.27 UJ       | 1990          | NR                 |
| 32-005-WR-2 | 89.8          | 806 J         | 12.1          | 7.97 J        | 86.9          | 77.9 J        | 26700         | 0.036         | 2790 J        | 79.1          | 588           | 9.36 J        | 7660          | NR                 |
| BACKGROUND  | 5.04 U        | 357 J         | 0.6 U         | 8.34 J        | 8.69          | 5.95 J        | 10700         | 0.144         | 2320 J        | 7.66          | 18.4          | 6.56 UJ       | 58.9          | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID       | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | TOTAL SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | PYRITIC<br>SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|----------------|-------------------|--------------------------------------|-------------------------------|---|------------------------|------------------------|------------------------|---|--|
| 32-005-WR-1    | 0.04              | 1.25                                 | 7.29                          | 6.04  | <0.01                  | 0.03                   | 0.01                   | 0.94                                      | 6.36   |
| 32-005-WR-2    | 0.62              | 19.4                                 | 32.5                          | 13.1  | 0.13                   | 0.15                   | 0.34                   | 4.69                                      | 27.8   |
| 32-005-WR-2DUP | 0.61              | 19.1                                 | 32.6                          | 13.6  | 0.13                   | 0.15                   | 0.33                   | 4.69                                      | 28   |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd    | Co    | Cr     | Cu     | Fe  | Hg       | Mn   | Ni      | Pb   | Sb     | Zn    | HARDNESS<br>CALC.<br>(mg CaCO3/L) |
|-------------|------|------|-------|-------|--------|--------|-----|----------|------|---------|------|--------|-------|-----------------------------------|
| 32-005-SW-1 | 3.34 | 81.7 | 2.9 J | 9.7 U | 6.83 U | 10.3 J | 238 | 0.12 UJX | 77.1 | 12.7 UX | 12.8 | 30.7 U | 243 J | 6.8                               |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD<br>I.D. | TOTAL<br>DISSOLVED<br>SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | TOTAL<br>CYANIDE |
|---------------|------------------------------|----------|---------|-----------|------------------|
| 32-005-SW-1   | 65                           | < 5.0    | < 5.0   | < 0.05    | NR               |

**LEGEND**

SE1 - Below outlet of settling pond in drainage.  
 WR1 - Composite of subsamples WR1A through 1D.  
 WR2 - Composite of subsamples WR2A and 2B.  
 BACKGROUND - From the Mill Creek Mine (32-049-SS-1).  
 WR2DUP - Duplicate of the 32-005-WR-2 sample.

SW1 - In trench prior to entering settling pond.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Upper Triantler</u>                | County: <u>Missoula</u>                         |
| Legal Description: T <u>12N</u> R <u>22W</u>          | Section(s): <u>NW 1/4, NW 1/4, Sec. 27</u>      |
| Mining District: <u>Woodman</u>                       | Mine Type: <u>Hardrock/Unknown, possibly Cu</u> |
| Latitude: <u>N 46° 46' 29"</u>                        | Primary Drainage: <u>Lolo Creek</u>             |
| Longitude: <u>W 114° 21' 32"</u>                      | USGS Code: <u>17010205</u>                      |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Lolo Creek</u>           |
| Quad: <u>Camp Creek</u>                               | Date Investigated: <u>September 8, 1993</u>     |
| Inspectors: <u>Bullock, Tuesday</u>                   | P.A. # <u>32-048</u>                            |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- No mill tailings were observed at this site during the investigation:
- The volume of waste rock associated with this site was estimated to be approximately 1,700 cubic yards. Metals concentrations in the waste rock were relatively low. The following elements were elevated at least three times background:  
Copper: 81.2 mg/kg  
Lead: 105 mg/kg
- No discharging adits, filled shafts, seeps, or springs were observed at the site during the investigation.
- Lolo Creek was identified approximately 200 feet south of the site and wetlands were identified approximately 50 feet west of the site; however, Lolo Creek was isolated from the site by Montana Highway 12 and the wetlands were isolated by a gravel road. No groundwater or surface water samples were collected due to a lack of runoff pathways.
- One potentially hazardous open shaft was identified northeast of and above the site on top of a ridge.

**Upper Triantler PA# 32-048**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 09/08/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 32-048-WR-1 | 4.79 U        | 57.1          | 0.5 U         | 8.23          | 5.22          | 81.2          | 15100         | 0.182 J       | 352           | 13.3          | 105           | 6.24 UJ       | 51 J          | NR                 |
| BACKGROUND  | 5.04 U        | 357 J         | 0.6 U         | 8.34 J        | 8.69          | 5.95 J        | 10700         | 0.144         | 2320 J        | 7.66          | 18.4          | 6.56 UJ       | 58.9          | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 32-048-WR-1 | 0.01              | 0.31                                 | 114                           | 114                                       | <0.01                  | 0.01                   | 0.04                   | 0.31                                      | 114                                       |

**LEGEND**

WR1 - Composite of subsamples WR1A and 1B.  
BACKGROUND - From the Mill Creek Mine (32-049-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Mill Creek Mine</u>                | County: <u>Missoula</u>                     |
| Legal Description: T <u>11N</u> R <u>21W</u>          | Section(s): <u>NE 1/4, NE 1/4, Sec. 9</u>   |
| Mining District: <u>Woodman</u>                       | Mine Type: <u>Hardrock/Au, Ag</u>           |
| Latitude: <u>N 46° 43' 55"</u>                        | Primary Drainage: <u>Lolo Creek</u>         |
| Longitude: <u>W 114° 14' 15"</u>                      | USGS Code: <u>17010205</u>                  |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Mill Creek</u>       |
| Quad: <u>Carlton Lake</u>                             | Date Investigated: <u>September 8, 1993</u> |
| Inspectors: <u>Bullock, Tuesday</u>                   | P.A. # <u>32-049</u>                        |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- No mill tailings were observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 315 cubic yards. The following elements were elevated at least three times background:

|                      |                    |
|----------------------|--------------------|
| Cobalt: 31.1J mg/kg  | Copper: 139J mg/kg |
| Mercury: 0.713 mg/kg | Iron: 40,300 mg/kg |
| Nickel: 28.1 mg/kg   |                    |
- No discharging adits, filled shafts, seeps, or springs were observed at or near the site during the investigation. Consequently, no groundwater or surface water samples were collected during the investigation.
- One minor intermittent stream bed was identified approximately 100 feet south of WR-1 (which was dry at the time of the investigation). No sediment samples were collected due to the absence of a direct runoff pathway.
- One potentially hazardous adit opening was identified at the site.



**Mill Creek PA# 32-049**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 09/08/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 32-049-WR-1 | 4.89 U        | 183 J         | 0.5 U         | 31.1 J        | 16.8          | 139 J         | 40300         | 0.713         | 741 J         | 28.1          | 12.9          | 6.36 UJ       | 77.2          | NR                 |
| BACKGROUND  | 5.04 U        | 357 J         | 0.6 U         | 8.34 J        | 8.69          | 5.95 J        | 10700         | 0.144         | 2320 J        | 7.66          | 18.4          | 6.56 UJ       | 58.9          | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL.<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|----------------------|---|--------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 32-049-WR-1 | <0.01                | 0                                       | 8.77                           | 8.77                                      | <0.01                  | <0.01                  | 0.01                   | 0   | 8.77                                      |

**LEGEND**

WR1 - Composite of subsamples WR1A and 1B.

BACKGROUND - From the Mill Creek Mine (32-049-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Allison</u>                        | County: <u>Park</u>                        |
| Legal Description: <u>T 7S R 9E</u>                   | Section(s): <u>SW 1/4, NE 1/4, Sec. 6</u>  |
| Mining District: <u>Emigrant</u>                      | Mine Type: <u>Hardrock/Au, Ag, Cu, Mo</u>  |
| Latitude: <u>N 45° 15' 28"</u>                        | Primary Drainage: <u>Yellowstone River</u> |
| Longitude: <u>W 110° 40' 02"</u>                      | USGS Code: <u>10070002</u>                 |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Emigrant Creek</u>  |
| Quad: <u>Emigrant</u>                                 | Date Investigated: <u>August 12, 1993</u>  |
| Inspectors: <u>Bullock, Belanger, Clark</u>           | P.A. # <u>34-018</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be 5660 cubic yards. Mercury (0.114-1.14 mg/kg) was the only element elevated at least three times background.
- The waste rock dumps were mostly unvegetated.
- The discharging adit, sampled as GW-1, was flowing at approximately 100 gpm, with a pH of 9.30, and a specific conductance of 80 umhos/cm. The discharge did not exceed any MCL/MCLGs; however, acute aquatic life standards for cadmium, copper, and zinc and chronic aquatic life standards for iron, cadmium, copper, lead, and zinc were exceeded in the adit discharge. A borehole at the base of WR-1 was also discharging at about 20 gpm. The pH from the discharge was neutral at 6.87, and had a specific conductance of 300 umhos/cm. This discharge, sampled as GW-2, did not exceed drinking water standards; however, it did exceed the acute aquatic life criteria for cadmium and zinc as well as the chronic aquatic life criteria for iron, cadmium, lead, and zinc.
- There were no direct runoff pathways from this site to Emigrant Creek in the drainage below, therefore, no samples were collected in the Creek.

**Allison PA# 34-018**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/12/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 34-018-WR-1 | 15.5       | 59.1 J     | 0.92 J     | 2.63       | 1.54       | 416        | 25800      | 0.114      | 365        | 3.17       | 232        | 6.24 UJ    | 80.5       | NR              |
| 34-018-WR-2 | 31.1       | 72.6 J     | 1.01 J     | 7.44       | 3.89       | 385        | 46800      | 1.14       | 329        | 4.55       | 126        | 5.41 UJ    | 119        | NR              |
| BACKGROUND  | 32.8       | 175 J      | 1.32 J     | 3.87       | 10.4       | 165        | 29500      | 0.028 U    | 484        | 9.84       | 242        | 6.52 UJ    | 96.5       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 34-018-WR-1 | 0.65           | 20.3                           | -0.21                    | -20.5                            | 0.30             | 0.02             | 0.33             | 0.62                             | -0.83                            |
| 34-018-WR-2 | 0.21           | 6.56                           | -0.26                    | -6.82                            | 0.14             | <0.01            | 0.08             | 0.00                             | -0.26                            |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd   | Co    | Cr     | Cu    | Fe    | Hg      | Mn  | Ni   | Pb   | Sb     | HARDNESS CALC. Zn (mg CaCO3/L) |
|-------------|------|------|------|-------|--------|-------|-------|---------|-----|------|------|--------|--------------------------------|
| 34-018-GW-1 | 4.1  | 9.57 | 2.83 | 12.1  | 6.83 U | 268 J | 12500 | 0.120 U | 989 | 25.7 | 1.84 | 30.7 U | 1050                           |
| 34-018-GW-2 | 18.3 | 18.4 | 4.63 | 9.7 U | 6.83 U | 2.3 J | 15100 | 0.120 U | 684 | 20.2 | 21.5 | 30.7 U | 2190                           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 34-018-GW-1 | 189                    | < 5.0    | 77      | < 0.05    | NR      |
| 34-018-GW-2 | 216                    | < 5.0    | 77      | < 0.05    | NR      |

**LEGEND**

WR1 - Composite of subsamples WR1A, 1B, 1C, and 1D.  
 WR2 - Composite of subsamples WR2A and 2B.  
 BACKGROUND - From the Allison Mine (34-018-SS-1).

GW1 - Discharging adit associated with waste rock dump 1.  
 SW1 - Discharge from bore hole at base of waste rock dump 1.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: McLaren Tailings  
Legal Description: T 19S R 14E  
Mining District: Cooke City  
Latitude: N 45° 01' 34"  
Longitude: W 109° 55' 29"  
Land Status: Private/Public  
Quad: Cooke City  
Inspectors: Bullock, Belanger, Clark  
Organization: Pioneer Technical Services, Inc.

County: Park  
Section(s): S 1/2, NE 1/4, Sec. 25  
Mine Type: Mill Tailings  
Primary Drainage: Yellowstone River  
USGS Code: 10070001  
Secondary Drainage: Soda Butte Creek  
Date Investigated: August 10, 1993  
P.A. # 34-004

- Previous reclamation work has been conducted on this site which included dam stabilization, run-on control, grading, covering and revegetation.
- The volume of tailings associated with this site was estimated to be approximately 370,000 cubic yards. The following elements were elevated at least three times background:

|                                |                            |
|--------------------------------|----------------------------|
| Cadmium: 2.58 to 3.0 mg/kg     | Copper: 1700 to 3680 mg/kg |
| Iron: 107,000 to 163,000 mg/kg | Mercury: 0.179 mg/kg       |
- The volume of waste rock associated with this site was estimated to be approximately 8,000 cubic yards. The following elements were elevated at least three times background:

|                     |                     |
|---------------------|---------------------|
| Arsenic: 45.3 mg/kg | Cadmium: 1.99 mg/kg |
| Copper: 846 mg/kg   | Iron: 105,000 mg/kg |
- A groundwater seep was identified at the toe of the tailings. No MCLs were exceeded in the seep; however, the chronic aquatic life criteria for iron was exceeded. In addition, no MCLs were exceeded in a sample collected from a monitoring well located at the west end of the tailings. Residents living directly downgradient of this site were serviced by a municipal water supply.
- Surface water samples were collected upstream and downstream from the site in Soda Butte Creek, and in Miller Creek prior to its confluence with Soda Butte Creek. An observed release to Soda Butte Creek was documented for iron; however, the concentration of iron in the downstream sample did not exceed any established standards. No MCLs were exceeded in any of the samples. The only aquatic life criteria exceedance observed was the chronic lead standard in the Miller Creek sample.



**McLaren Tailings PA# 34-004**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/10/93**

**SOLID MATRIX ANALYSES**

| Metals in soils   |                | Results per dry weight basis   |                          |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
|---|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|------------|------------|------------|------------|-----------------|
| FIELD ID  | As (mg/Kg)     | Ba (mg/Kg)                     | Cd (mg/Kg)               | Co (mg/Kg)                       | Cr (mg/Kg)       | Cu (mg/Kg)       | Fe (mg/Kg)       | Hg (mg/Kg)                       | Mn (mg/Kg)                       | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 34-004-SE-1   | 10.6 J         | 86.2                           | 0.61 U                   | 11.9                             | 14.4 J           | 214              | 20400            | 0.047                            | 557                              | 19.7       | 59.1       | 7.24 UJ    | 98.2       | NR              |
| 34-004-SE-2   | 7.37 J         | 93.5                           | 0.60 U                   | 12.9                             | 17 J             | 243              | 15400            | 0.035 U                          | 504                              | 23.1       | 55.1       | 7.11 UJ    | 98.7       | NR              |
| 34-004-SE-3   | 4.12 U         | 88                             | 0.45 U                   | 7.91                             | 13 J             | 103              | 20500            | 0.04 U                           | 658                              | 14.3       | 116        | 5.36 UJ    | 102        | NR              |
| 34-004-TP-1   | 26.3 J         | 73.8                           | 2.58                     | 6.79                             | 17.5 J           | 1700             | 107000           | 0.105                            | 217                              | 10.4       | 69         | 7.16 UJ    | 81.9       | NR              |
| 34-004-TP-2   | 41.6 J         | 69.3                           | 3.00                     | 12.8                             | 21.6 J           | 3680             | 163000           | 0.179                            | 576                              | 14.4       | 104        | 6.71 UJ    | 162        | NR              |
| 34-004-WR-1   | 45.3 J         | 101                            | 1.99                     | 5.13                             | 17.5 J           | 846              | 105000           | 0.099                            | 191                              | 8.87       | 208        | 6.18 UJ    | 80.1       | NR              |
| BACKGROUND  | 14.6 J         | 89                             | 0.4 U                    | 10.5 J                           | 30.7             | 40               | 23300            | 0.058 J                          | 1450 J                           | 20.7       | 158 J      | 5.17 U     | 181        | NR              |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                |                                |                          |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
| Acid/Base Accounting  |                |                                |                          |                                  |                  |                  |                  |                                  |                                  |            |            |            |            |                 |
| FIELD ID  | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |            |            |            |            |                 |
| 34-004-TP-1   | 6.10           | 191                            | 116                      | -74.9                            | <0.01            | 7.05             | 0.82             | 220                              | -105                             |            |            |            |            |                 |
| 34-004-TP-2   | 14.1           | 440                            | 9.83                     | -431                             | 2.89             | 4.21             | 7.00             | 132                              | -122                             |            |            |            |            |                 |
| 34-004-WR-1   | 1.14           | 35.6                           | -3.22                    | -38.8                            | 0.76             | 0.01             | 0.37             | 0.31                             | -3.53                            |            |            |            |            |                 |

**WATER MATRIX ANALYSES**

| Metals in Water   |          |      |        |       |        |         |        |      |      |        |        |        |                 |                |
|---|----------|------|--------|-------|--------|---------|--------|------|------|--------|--------|--------|-----------------|----------------|
| Results in ug/L   |          |      |        |       |        |         |        |      |      |        |        |        |                 |                |
| FIELD ID  | As       | Ba   | Cd     | Co    | Cr     | Cu      | Fe     | Hg   | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
| 34-004-GW-1   | 1.57 JX  | 58.7 | 2.57 U | 32    | 6.83 U | 4.37 JX | 117000 | 0.29 | 4240 | 26.5 J | 2.28 J | 30.7 U | 79              | 731            |
| 34-004-GW-2   | 1.43 JX  | 25   | 2.57 U | 9.7 U | 17.1   | 3.1 JX  | 96200  | 0.22 | 2010 | 12.7 U | 2.95 J | 30.7 U | 7.57 U          | 2850           |
| 34-004-SW-1   | 1.12 UJX | 45.7 | 2.57 U | 9.7 U | 6.83 U | 8.87 JX | 827    | 0.22 | 82.8 | 12.7 U | 3.2 J  | 30.7 U | 9.1             | 119            |
| 34-004-SW-2   | 1.14 JX  | 29.3 | 2.57 U | 9.7 U | 6.83 U | 8.5 JX  | 75.6   | 0.22 | 5.03 | 12.7 U | 3.05 J | 30.7 U | 13.8            | 78.7           |
| 34-004-SW-3   | 1.84 JX  | 54.8 | 2.57 U | 9.7 U | 6.83 U | 4.1 JX  | 32.8   | 0.4  | 5.77 | 15.7 J | 2.3 J  | 30.7 U | 11.3            | 125            |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |          |      |        |       |        |         |        |      |      |        |        |        |                 |                |

| Wet Chemistry   |                        |          |         |           |         |
|-----------------|------------------------|----------|---------|-----------|---------|
| Results in mg/l |                        |          |         |           |         |
| FIELD ID        | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
| 34-004-GW-1     | 1180                   | 5        | 692     | < 0.05    | NR      |
| 34-004-GW-2     | 4360                   | 5        | 2660    | < 0.05    | NR      |
| 34-004-SW-1     | 165                    | < 5.0    | 25      | < 0.05    | NR      |
| 34-004-SW-2     | 115                    | 7        | 21      | < 0.05    | NR      |
| 34-004-SW-3     | 155                    | < 5.0    | 7       | < 0.05    | NR      |

| LEGEND  |   |
|---|---|
| SE1 - Downgradient on Soda Butte Creek.                                       | GW1 - Seepage at toe of tailings.           |
| SE2 - Miller Ck. just above confluence with Soda Butte Creek.                 | GW2 - Monitor well at West end of tailings. |
| SE3 - Upgradient on Soda Butte Creek.   | SW1 - Same as sample SE1.                   |
| TP1 - Composite of subsamples TP1A-A, 1B-A, and 1C-A.                         | SW2 - Same as sample SE2.                   |
| TP2 - Composite of subsamples TP1A-B, 1B-B, 1B-C, 1B-D, 1B-E, 1C-B, and 1C-C. | SW3 - Same as sample SE3.                   |
| WR1 - Composite of subsamples WR1A and 1B.                                    |   |
| BACKGROUND - From the Little Daisy Mine (34-009-SS-1).                        |   |

**LEGEND**

SE1 - Downgradient on Soda Butte Creek.  
 SE2 - Miller Ck. just above confluence with Soda Butte Creek.  
 SE3 - Upgradient on Soda Butte Creek.  
 TP1 - Composite of subsamples TP1A-A, 1B-A, and 1C-A.  
 TP2 - Composite of subsamples TP1A-B, 1B-B, 1B-C, 1B-D, 1B-E, 1C-B, and 1C-C.  
 WR1 - Composite of subsamples WR1A and 1B.  
 BACKGROUND - From the Little Daisy Mine (34-009-SS-1).

GW1 - Seepage at toe of tailings.  
 GW2 - Monitor well at West end of tailings.  
 SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.  
 SW3 - Same as sample SE3.

# MONTANA DEPARTMENT OF STATE LANDS ABANDONED MINE RECLAMATION BUREAU HAZARDOUS MATERIALS INVENTORY SITE SUMMARY

|   |   |
|---|---|
| Mine/Site Name: <u>Lower Glengarry</u>                | County: <u>Park</u>                                   |
| Legal Description: <u>T 9S R 14E</u>                  | Section(s): <u>NW 1/4, NE 1/4, Sec. 11</u>            |
| Mining District: <u>New World</u>                     | Mine Type: <u>Hardrock/Au</u>                         |
| Latitude: <u>N 45° 04' 05"</u>                        | Primary Drainage: <u>Clark Fork Yellowstone River</u> |
| Longitude: <u>W 109° 56' 05"</u>                      | USGS Code: <u>10070006</u>                            |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Fisher Creek</u>               |
| Quad: <u>Cooke City</u>                               | Date Investigated: <u>August 9, 1993</u>              |
| Inspectors: <u>Bullock, Belanger, Clark</u>           | P.A. # <u>34-006</u>                                  |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- The volume of tailings associated with this site was estimated to be approximately 782 cubic yards. The following elements were elevated at least three times background:  
Copper: 377 mg/kg  
Lead: 106J mg/kg  
Iron: 141,000 mg/kg
- The volume of waste rock associated with this site was estimated to be approximately 17,000 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 50.2J to 53.6J mg/kg  
Copper: 421 to 1260 mg/kg  
Mercury: 2.14J mg/kg  
Cadmium: 3.6 mg/kg  
Iron: 60,000 to 185,000 mg/kg  
Lead: 109J to 116J mg/kg
- Two discharging adits and a groundwater seep (located at the base of WR-1) were observed at the site during the investigation. The discharge from Adit #1 exceeded the MCL for copper and acute and chronic aquatic life criteria for copper and zinc. Additionally, the Adit #1 discharge exceeded the chronic aquatic life criteria for iron, mercury, and lead. The discharge from Adit #2 and the seep exceeded the acute and chronic aquatic life criteria for copper and zinc as well as chronic aquatic life criteria for iron, mercury, and lead. Adit discharge pH measurements were 3.23 and 3.85 for Adit #1 and Adit #2, respectively; and the pH measurement in the seep was 3.43.
- Several surface water and sediment samples were collected at the site during the investigation, including: upstream and downstream samples in Fisher Creek; and samples from an unnamed tributary to Fisher Creek. Observed releases of iron, mercury, and lead were documented and attributable to this site. The MCL/MCLG for copper was exceeded and attributable to this site. Although several aquatic life criteria were exceeded upstream and downstream of the site, the chronic criteria for iron was the only standard attributable to the site. The upstream surface water samples indicated the presence of an upgradient source (the Upper Glengarry Mine).
- Potential hazards that were observed at the site included two adits (one with a locked gate, and one partially caved-in) and two collapsing cabins.

**Lower Glengarry PA# 34-006**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/09/93**

**SOLID MATRIX ANALYSES**

| SOLID MATRIX ANALYSES   |                      |            |                              |            |            |            |            |            |            |            |            |            |            |                 |
|---|----------------------|------------|------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| FIELD ID  | Metals in soils      |            | Results per dry weight basis |            |            |            |            |            |            |            |            |            |            |                 |
|   | As (mg/Kg)           | Ba (mg/Kg) | Cd (mg/Kg)                   | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 34-006-SE-1   | 86.6 J               | 113        | 0.6 U                        | 4.14 J     | 9.39       | 371        | 57500      | 0.066 J    | 492 J      | 2.76 U     | 92.1 J     | 6.69 U     | 74         | NR              |
| 34-006-SE-2   | 20.1 J               | 76.2       | 0.7 U                        | 5.5 J      | 11.8       | 601        | 93900      | 0.051 J    | 494 J      | 5.45       | 377 J      | 8.46 U     | 197        | NR              |
| 34-006-SE-3   | 74.6 J               | 98.8       | 0.7 U                        | 2.83 J     | 6.21       | 415        | 54500      | 0.042 J    | 319 J      | 5.21       | 73.1 J     | 8.39 U     | 67.9       | NR              |
| 34-006-TP-1   | 22.6 J               | 33.4       | 0.7 U                        | 3.96 J     | 32.1       | 377        | 141000     | 0.036 J    | 73.7 J     | 5.1        | 106 J      | 8.42 U     | 41.1       | NR              |
| 34-006-WR-1   | 50.2 J               | 142        | 0.5 U                        | 2.11 J     | 4.67       | 421        | 60000      | 2.14 J     | 233 J      | 2.34 U     | 109 J      | 5.67 U     | 29.1       | NR              |
| 34-006-WR-2   | 53.6 J               | 11.8       | 3.6                          | 1.96 U     | 1.38 U     | 1260       | 185000     | 0.038 J    | 1.45 J     | 2.56 U     | 116 J      | 6.2 U      | 50.1       | NR              |
| BACKGROUND  | 8.61 J               | 71.7       | 0.9                          | 12.4 J     | 27         | 66.9       | 17100      | 0.02 J     | 461 J      | 23.9       | 28.3 J     | 5.49 U     | 69.9       | NR              |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                      |            |                              |            |            |            |            |            |            |            |            |            |            |                 |
| FIELD ID  | Acid/Base Accounting |            |                              |            |            |            |            |            |            |            |            |            |            |                 |
|   | TOTAL                | TOTAL      | NEUTRAL.                     | SULFUR     | SULFATE    | PYRITIC    | ORGANIC    | PYRITIC    | SULFUR     |            |            |            |            |                 |
|   | SULFUR               | SULFUR     | POTENT.                      | ACID BASE  | SULFUR     | SULFUR     | SULFUR     | SULFUR     | ACID BASE  | ACID BASE  | POTENT.    |            |            |                 |
|   | %                    | µ/1000t    | µ/1000t                      | µ/1000t    | %          | %          | %          | µ/1000t    | µ/1000t    |            |            |            |            |                 |
| 34-006-WR-1   | 0.77                 | 24.1       | -1.68                        | -25.7      | 0.23       | 0.16       | 0.38       | 5.00       | -6.68      |            |            |            |            |                 |
| 34-006-WR-2   | 45.6                 | 1426       | -4.79                        | -1431      | 0.31       | <0.01      | 47.2       | 0.00       | -4.79      |            |            |            |            |                 |
| 34-006-WR-3   | 0.75                 | 23.4       | -4.13                        | -27.6      | 0.32       | <0.01      | 0.53       | 0.00       | -4.13      |            |            |            |            |                 |

**WATER MATRIX ANALYSES**

| FIELD ID  | Metals in Water Results in ug/L |      |        |       |        |         |          |        |      |        |      |        | HARDNESS                     |       |
|---|---------------------------------|------|--------|-------|--------|---------|----------|--------|------|--------|------|--------|------------------------------|-------|
|   | As                              | Ba   | Cd     | Co    | Cr     | Cu      | Fe       | Hg     | Mn   | Ni     | Pb   | Sb     | Zn (mg CaCO <sub>3</sub> /L) | CALC. |
| 34-006-GW-1   | 7.31                            | 8.3  | 2.57 U | 46.1  | 10.6   | 7730 JX | 85600 JX | 0.09 J | 5610 | 99.2 J | 40.1 | 30.7 U | 671                          | 202   |
| 34-006-GW-2   | 2.27                            | 13.7 | 2.57 U | 21.4  | 6.83 U | 121 JX  | 14200 JX | 0.11 J | 1020 | 20.5 J | 2.45 | 30.7 U | 127                          | 38.8  |
| 34-006-SW-1   | 1.21                            | 28.6 | 2.57 U | 11.7  | 6.83 U | 1340 JX | 7960 JX  | 0.25 J | 794  | 26 J   | 9.56 | 30.7 U | 133                          | 47.2  |
| 34-006-SW-2   | 1.89                            | 20.1 | 2.57 U | 15.4  | 6.83 U | 1170 JX | 3160 JX  | 0.08 J | 722  | 32.5 J | 8.2  | 30.7 U | 137                          | 42.6  |
| 34-006-SW-3   | 1.93                            | 37.1 | 2.57 U | 9.7 U | 6.83 U | 761 JX  | 187 JX   | 0.07 J | 56.4 | 12.7 U | 3.17 | 30.7 U | 34.7                         | 7.1   |
| 34-006-SW-4   | 0.96 U                          | 42.5 | 2.57 U | 9.7 U | 6.83 U | 646 JX  | 3750 JX  | 0.09 J | 346  | 13.9 J | 6.49 | 30.7 U | 55.9                         | 24.9  |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                                 |      |        |       |        |         |          |        |      |        |      |        |                              |       |

**Wet Chemistry**

**Results in mg/l**

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO <sub>3</sub> /NO <sub>2</sub> -N | CYANIDE |
|-------------|------------------------|----------|---------|-------------------------------------|---------|
|             |                        |          |         |                                     |         |
| 34-006-GW-1 | 763                    | 10       | 489     | < 0.05                              | NR      |
| 34-006-GW-2 | 165                    | < 5.0    | 77      | < 0.05                              | NR      |
| 34-006-SW-1 | 168                    | < 5.0    | 87      | < 0.05                              | NR      |
| 34-006-SW-2 | 186                    | < 5.0    | 94      | < 0.05                              | NR      |
| 34-006-SW-3 | 98                     | < 5.0    | 26      | 0.11                                | NR      |
| 34-006-SW-4 | 121                    | < 5.0    | 56      | 0.05                                | NR      |

**LEGEND**

- |   |   |
|---|---|
| SE1 - Downgradient of site on Fisher Creek.               | GW1 - Discharge from adit #1.                           |
| SE2 - Upgradient of site on headwaters of Fisher Creek.   | GW2 - Discharge from adit #2.                           |
| SE3 - Upgradient stream (unnamed).                        | SW1 - Downgradient of site on Fisher Creek.             |
| TP1 - Composite of subsamples TP1A, 1B, and 1C.           | SW2 - Discharge from waste rock dump 1 base.            |
| WR1 - Composite of subsamples WR1A, 1B, and 1C.           | SW3 - Upgradient of site on headwaters of Fisher Creek. |
| WR2 - Sample of the WR2 subsample.                        | SW4 - Upgradient stream (unnamed).                      |
| BACKGROUND - From the Lower Glengarry Mine (34-006-SS-1). |   |



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Gold Dust</u>                      | County: <u>Park</u>                             |
| Legal Description: T <u>9S</u> R <u>14E</u>           | Section(s): <u>SE 1/4, SE 1/4, Sec. 11</u>      |
| Mining District: <u>New World</u>                     | Mine Type: <u>Hardrock/Au</u>                   |
| Latitude: <u>N 45° 04' 01"</u>                        | Primary Drainage: <u>Clark Fork Yellowstone</u> |
| Longitude: <u>W 109° 56' 33"</u>                      | <u>River</u>                                    |
| Land Status: <u>Private/Public</u>                    | USGS Code: <u>10070006</u>                      |
| Quad: <u>Cooke City</u>                               | Secondary Drainage: <u>Fisher Creek</u>         |
| Inspectors: <u>Bullock, Belanger, Clark</u>           | Date Investigated: <u>August 9, 1993</u>        |
| Organization: <u>Pioneer Technical Services, Inc.</u> | P.A. # <u>34-007</u>                            |

- There were no mill tailings observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 8,000 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 34.9J to 40.3J mg/kg      Mercury: 0.256J to 1.15J mg/kg
- One discharging adit was identified at the site. No MCLs were exceeded in the adit discharge; however, the chronic aquatic life criteria for mercury was exceeded.
- An unnamed tributary to Fisher Creek was observed flowing adjacent to the waste rock dump at the site and received the adit discharge. There were no documented releases to this drainage and no MCL/MCLGs were exceeded in surface water samples collected upstream and downstream from the site. The stream sediment samples documented an observed release to the tributary for mercury.
- A potentially hazardous wooden loadout structure was identified at the site, and explosives may have been stored in the newer mine buildings.



**Gold Dust PA# 34-007**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/09/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 34-007-SE-1 | 20.2 J     | 76.8       | 1.3        | 12.8 J     | 19.7       | 378        | 33200      | 0.065 J    | 835 J      | 25.9       | 245 J      | 6.51 U     | 403        | NR              |
| 34-007-SE-2 | 19.1 J     | 48.3       | 1.9        | 24.1 J     | 11.4       | 547        | 23500      | 0.014 J    | 1580 J     | 33.8       | 309 J      | 8.13 U     | 472        | NR              |
| 34-007-WR-1 | 40.3 J     | 85.8       | 0.8        | 4.2 J      | 14.1       | 180        | 47600      | 1.15 J     | 157 J      | 8.74       | 68.2 J     | 5.93 U     | 66.1       | NR              |
| 34-007-WR-2 | 34.9 J     | 56.9       | 0.5 U      | 10.6 J     | 20.4       | 98.4       | 30500      | 0.256 J    | 339 J      | 24.8       | 51.2 J     | 5.45 U     | 83.3       | NR              |
| BACKGROUND  | 8.61 J     | 71.7       | 0.9        | 12.4 J     | 27         | 66.9       | 17100      | 0.02 J     | 461 J      | 23.9       | 28.3 J     | 5.49 U     | 69.9 JX    | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 34-007-WR-1 | 0.27           | 8.43                           | 0.35                     | -8.08                            | 0.12             | 0.04             | 0.11             | 1.25                             | -0.90                            |
| 34-007-WR-2 | 4.67           | 146                            | 61.6                     | -84.3                            | <0.01            | 2.06             | 2.83             | 64.4                             | -2.76                            |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co    | Cr     | Cu      | Fe      | Hg     | Mn   | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|------|--------|-------|--------|---------|---------|--------|------|--------|------|--------|-----------------|----------------|
| 34-007-GW-1 | 3.06 | 16.9 | 2.57 U | 9.7 U | 6.83 U | 6.53 JX | 144 JX  | 0.11 J | 55.7 | 13.5 J | 2.17 | 30.7 U | 11.1            | 381            |
| 34-007-SW-1 | 1.81 | 38.4 | 2.57 U | 9.7 U | 6.83 U | 11.4 JX | 58.7 JX | 0.06 J | 13   | 15 J   | 2.9  | 30.7 U | 70              | 152            |
| 34-007-SW-2 | 1.39 | 38   | 2.57 U | 9.7 U | 6.83 U | 11.5 JX | 40 JX   | 0.1 J  | 11.3 | 12.7 U | 3.58 | 30.7 U | 96.1            | 138            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 34-007-GW-1 | 581                    | < 5.0    | 282     | 0.07      | NR      |
| 34-007-SW-1 | 256                    | < 5.0    | 117     | 0.06      | NR      |
| 34-007-SW-2 | 231                    | < 5.0    | 109     | 0.18      | NR      |

**LEGEND**

SE1 - Downgradient of site in unnamed stream.  
SE2 - Upgradient of site in unnamed stream.  
WR1 - Composite of subsamples WR1A and 1D.  
WR2 - Composite of subsamples WR1B and 1C.  
BACKGROUND - From the Lower Glengarry (34-006-SS-1).

GW1 - Discharge from adit.  
SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Little Daisy</u>                   | County: <u>Park</u>                           |
| Legal Description: <u>T 9S R 14E</u>                  | Section(s): <u>NW 1/4, NW 1/4, Sec. 14</u>    |
| Mining District: <u>New World</u>                     | Mine Type: <u>Hardrock/Au, Ag, Cu, Zn, Pb</u> |
| Latitude: <u>N 45° 03' 10"</u>                        | Primary Drainage: <u>Soda Butte Creek</u>     |
| Longitude: <u>W 109° 57' 09"</u>                      | USGS Code: <u>10070001</u>                    |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Miller Creek</u>       |
| Quad: <u>Cooke City</u>                               | Date Investigated: <u>August 9, 1993</u>      |
| Inspectors: <u>Babits, Flammang, Lasher</u>           | P.A. # <u>34-009</u>                          |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no mill tailings associated with this site.
- There were approximately 3,220 cubic yards of mostly covered waste rock on site. The following were elevated at least 3 times background:
  - Cadmium: 1.7 to 2.3 mg/kg
  - Copper: 138 to 1,520 mg/kg
  - Iron: 78,200 to 80,500 mg/kg
  - Mercury: 0.222J to 1.08J mg/kg
  - Zinc: 546 mg/kg
- There were two discharging adits on site, but neither entered surface water directly; pH's were 7.24 and 7.60. One adit was sampled; no MCL/MCLG's were exceeded.
- Miller Creek flows adjacent to waste rock. There were no observed releases to downstream surface water or sediment. No MCL/MCLGs were exceeded in downstream surface water. Chronic fresh water aquatic life criteria for mercury and lead were exceeded in both upstream and downstream surface water, indicating an upstream source.
- There were no hazardous openings on site.

Little Daisy PA# 34-009  
AMRB HAZARDOUS MATERIALS INVENTORY  
INVESTIGATOR: PIONEER - BABITS  
INVESTIGATION DATE: 08/09/93

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 34-009-SE-1 | 12.7 U     | 136        | 1.4 U      | 22.4 J     | 43.9       | 279        | 38200      | 0.097 J    | 2610 J     | 42.7       | 72.9 J     | 16.5 U     | 380        | NR              |
| 34-009-SE-2 | 11.4 J     | 46.5       | 0.6 U      | 7.9 J      | 12.4       | 146        | 22100      | 0.105 J    | 593 J      | 11.6       | 92.4 J     | 6.8 U      | 106        | NR              |
| 34-009-WR-1 | 19.1 J     | 26.3       | 1.7        | 3.94 J     | 27.7       | 1520       | 80500      | 1.08 J     | 1510 J     | 19.3       | 238 J      | 4.69 U     | 201        | NR              |
| 34-009-WR-2 | 17.4 J     | 71.2       | 2.3        | 9.91 J     | 24.8       | 763        | 78200      | 0.175 J    | 2520 J     | 19.9       | 431 J      | 6.28 U     | 546        | NR              |
| 34-009-WR-3 | 7.22 J     | 29         | 0.5 U      | 12.5 J     | 17.1       | 138        | 29400      | 0.222 J    | 618 J      | 17.1       | 49.3 J     | 5.99 U     | 35.1       | NR              |
| BACKGROUND  | 14.6 J     | 89         | 0.4 U      | 10.5 J     | 30.7       | 40         | 23300      | 0.058 J    | 1450 J     | 20.7       | 158 J      | 5.17 U     | 181        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 34-009-WR-1 | 3.59           | 112                            | 48.6                    | -63.6                            | <0.01            | 2.00             | 1.87             | 62.5                             | -13.9                            |
| 34-009-WR-2 | 0.35           | 10.9                           | 15.8                    | 4.90                             | 0.01             | 0.06             | 0.28             | 1.87                             | 14.0                             |
| 34-009-WR-3 | 0.51           | 15.9                           | 74.7                    | 58.7                             | 0.13             | 0.07             | 0.31             | 2.19                             | 72.5                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co    | Cr     | Cu      | Fe       | Hg     | Mn   | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|------|--------|-------|--------|---------|----------|--------|------|--------|------|--------|-----------------|----------------|
| 34-009-GW-1 | 3.17 | 9.03 | 2.57 U | 9.7 U | 6.83 U | 96.1 JX | 4150 JX  | 0.07 J | 1460 | 37.2 J | 526  | 30.7 U | 167             | 551            |
| 34-009-SW-1 | 2.08 | 19.6 | 2.57 U | 9.7 U | 6.83 U | 4.97 JX | 11.8 UJX | 0.12 J | 10.4 | 12.7 U | 1.79 | 30.7 U | 7.57 U          | 161            |
| 34-009-SW-2 | 1.5  | 19.5 | 2.57 U | 9.7 U | 6.83 U | 5.27 JX | 24 JX    | 0.09 J | 5.97 | 12.7 U | 2.96 | 30.7 U | 7.57 U          | 155            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 34-009-GW-1 | 730                    | 6        | 341     | 0.31      | NR      |
| 34-009-SW-1 | 234                    | < 5.0    | 76      | 0.57      | NR      |
| 34-009-SW-2 | 235                    | < 5.0    | 75      | 0.57      | NR      |

**LEGEND**

SE1 - Headwaters of unnamed tributary of Miller Creek.  
SE2 - In unnamed tributary at PPE of waste rock dump 6.  
WR1 - Composite of subsamples WR1A and 1B.  
WR2 - Composite of subsamples WR2A, 2B, 3, and 4.  
WR3 - Composite of subsamples WR5 and 6.  
BACKGROUND - 100' West, 50' to North of adit #1 (WR-1).  
From Little Daisy Mine (34-009-SS-1).

SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>McLaren Mine</u>                   | County: <u>Park</u>                         |
| Legal Description: <u>T 9S R 14E</u>                  | Section(s): <u>NW 1/4, SW 1/4, Sec. 11</u>  |
| Mining District: <u>New World</u>                     | Mine Type: <u>Hardrock/Unknown</u>          |
| Latitude: <u>N 45° 03' 35"</u>                        | Primary Drainage: <u>Stillwater River</u>   |
| Longitude: <u>W 109° 57' 30"</u>                      | USGS Code: <u>10070005</u>                  |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Stillwater River</u> |
| Quad: <u>Cooke City</u>                               | Date Investigated: <u>August 9, 1993</u>    |
| Inspectors: <u>Babits, Flammang, Lasher</u>           | P.A. # <u>34-010</u>                        |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no mill tailings associated with this site.
- There were approximately 351,500 cubic yards of uncovered waste rock on site. The following were elevated at least three times background:  
Cadmium: 1.9 to 2.81 mg/kg  
Copper: 885 to 1,030 mg/kg  
Cobalt: 47J mg/kg  
Iron: 92,000 to 152,000 mg/kg
- There was one discharging adit on site, but it did not enter surface water directly. There were seeps emanating from the waste rock which entered surface water. One seep was sampled and had a pH of 3.21. The MCL/MCLGs for cadmium, copper, and nickel were exceeded, as was the chronic fresh water aquatic life criteria for iron. The chronic and acute fresh water aquatic life criteria for cadmium, copper, and zinc were exceeded.
- The seeps entered Daisy Creek 1,000 feet from the site. The seeps made up the flow of the creek, hence, no upstream surface water samples were collected. At the location the seeps entered Daisy Creek, cadmium and lead exceeded MCL/MCLGs, and the chronic fresh water aquatic life criteria for iron was exceeded. The chronic and acute fresh water aquatic life criteria for copper was also exceeded.
- There were no hazardous openings on site; but, there was one large highwall.



**McLaren PA# 34-010**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/09/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 34-010-SE-1 | 33.5 J     | 41.1       | 2.0        | 3.14 J     | 14.7       | 1110       | 131000     | 0.257 J    | 195 J      | 4.7        | 107 J      | 6.79 U     | 123        | NR              |
| 34-010-WR-1 | 36.3 J     | 45.6       | 1.9        | 47 J       | 1.51       | 1030       | 152000     | 0.077 J    | 27.6 J     | 21.7       | 35.4 J     | 5.92 U     | 7.71       | NR              |
| 34-010-WR-2 | 32.9 J     | 143        | 2.81       | 3.51       | 11.1 J     | 887        | 120000     | 0.091      | 117        | 7.57       | 112        | 7.43 UJ    | 50.2       | NR              |
| 34-010-WR-3 | 27.4 J     | 71.5       | 2.68       | 5.37       | 23.4 J     | 885        | 92000      | 0.049      | 242        | 9.9        | 222        | 6.76 UJ    | 192        | NR              |
| BACKGROUND  | 14.6 J     | 89         | 0.4 U      | 10.5 J     | 30.7       | 40         | 23300      | 0.058 J    | 1450 J     | 20.7       | 158 J      | 5.17 U     | 181        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 39-010-WR-1 | 18.2           | 567                            | -14.5                    | -582                             | 8.18             | 1.23             | 8.75             | 38.4                             | -53.0                            |
| 39-010-WR-2 | 1.33           | 41.5                           | -3.30                    | -44.8                            | 0.59             | <0.01            | 0.80             | 0.00                             | -3.30                            |
| 39-010-WR-3 | 0.55           | 17.2                           | 5.47                     | -11.7                            | 0.19             | <0.01            | 0.36             | 0.00                             | 5.47                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As       | Ba     | Cd     | Co   | Cr   | Cu       | Fe     | Hg   | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|----------|--------|--------|------|------|----------|--------|------|------|--------|--------|--------|-----------------|----------------|
| 34-010-SW-1 | 1.34 JX  | 27.4   | 6.3 J  | 35.8 | 14.2 | 6520 JX  | 24300  | 1.93 | 2240 | 63.8 J | 5.08 J | 30.7 U | 817             | 203            |
| 34-010-SW-5 | 1.12 UJX | 2.01 U | 20.3 J | 133  | 41.7 | 26700 JX | 192000 | 0.48 | 7150 | 141 J  | 6.47 J | 30.7 U | 3000            | 344            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 34-010-SW-1 | 583                    | < 5.0    | 356     | < 0.05    | NR      |
| 34-010-SW-5 | 1870                   | 55       | 1210    | < 0.05    | NR      |

**LEGEND**

SE1 - At confluence of three mine drainages, approx. 1000' from pit at Daisy Pass Road.

SW1 - Same as sample SE1.

WR1 - Composite of subsamples WR1A and 1B.

SW5 - Discharge emanating from dump.

WR2 - Composite of subsamples WR2A, 2B, and 2D.

WR3 - Sample of the WR2C subsample.

BACKGROUND - From the Little Daisy Mine (34-009-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Black Warrior</u>                  | County: <u>Park</u>                        |
| Legal Description: <u>T 9S R 14E</u>                  | Section(s): <u>NE 1/4, SE 1/4, Sec. 15</u> |
| Mining District: <u>New World</u>                     | Mine Type: <u>Hardrock/Ag, Au, Zn, Pb</u>  |
| Latitude: <u>N 45° 02' 05"</u>                        | Primary Drainage: <u>Soda Butte Creek</u>  |
| Longitude: <u>W 109° 57' 55"</u>                      | USGS Code: <u>10070001</u>                 |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Miller Creek</u>    |
| Quad: <u>Cooke City</u>                               | Date Investigated: <u>August 9, 1993</u>   |
| Inspectors: <u>Babits, Flammang, Lasher</u>           | P.A. # <u>34-079</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no mill tailings associated with this site.
- There were approximately 1,100 cubic yards of mostly uncovered waste rock on site. The following were elevated at least 3 times background:
  - Arsenic: 54J mg/kg
  - Cadmium: 7.76 mg/kg
  - Copper: 981 mg/kg
  - Mercury: 0.93 mg/kg
  - Lead: 14,600 mg/kg
  - Antimony: 25.2J mg/kg
  - Zinc: 2,490 mg/kg
- There were two discharging adits on site and both entered surface water directly. One adit discharge sample was collected; the pH was 7.22. The MCL for lead was exceeded, as was the chronic fresh water aquatic life criteria for iron and lead. The chronic and acute fresh water aquatic life criteria were exceeded for copper and zinc.
- Miller Creek flows adjacent to waste rock and there was an observed release of zinc documented to downstream surface water. No MCL/MCLGs were exceeded. The fresh water aquatic life criteria for mercury and lead were exceeded in both upstream and downstream surface water, indicating an upstream source.
- There was one open shaft with subsidence, one open adit, one hazardous loadout structure, and one collapsing cabin on site.

**Black Warrior PA# 34-079**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/09/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 34-079-SE-1 | 10.9 J        | 62            | 0.92          | 9.67          | 17.8 J        | 35.5          | 17600         | 0.041         | 494           | 23            | 168           | 8.14 UJ       | 131           | NR                 |
| 34-079-SE-2 | 7.82 U        | 67.1          | 5.55          | 8.14          | 20.2 J        | 37.8          | 10000         | 0.055 U       | 61.8          | 20.8          | 78.5          | 10.2 UJ       | 743           | NR                 |
| 34-079-WR-1 | 54 J          | 52.3          | 7.76          | 6.34          | 11.2 J        | 981           | 65000         | 0.93          | 736           | 13.2          | 14600         | 25.2 J        | 2490          | NR                 |
| BACKGROUND  | 14.6 J        | 89            | 0.4 U         | 10.5 J        | 30.7          | 40            | 23300         | 0.058 J       | 1450 J        | 20.7          | 158 J         | 5.17 U        | 181           | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR ACID BASE<br>t/1000t | NEUTRAL POTENT.<br>t/1000t | SULFUR ACID BASE POTENT.<br>t/1000t | SULFATE SULFUR<br>% | PYRITIC SULFUR<br>% | ORGANIC SULFUR<br>% | PYRITIC SULFUR ACID BASE<br>t/1000t | SULFUR ACID BASE POTENT.<br>t/1000t |
|-------------|-------------------|-----------------------------------|----------------------------|-------------------------------------|---------------------|---------------------|---------------------|-------------------------------------|-------------------------------------|
| 34-079-WR-1 | 5.56              | 174                               | 166                        | -8.17                               | <0.01               | 3.22                | 4.36                | 101                                 | 64.9                                |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As       | Ba   | Cd     | Co    | Cr     | Cu      | Fe   | Hg   | Mn   | Ni     | Pb     | Sb     | Zn<br>(mg CaCO3/L) | HARDNESS<br>CALC. |
|-------------|----------|------|--------|-------|--------|---------|------|------|------|--------|--------|--------|--------------------|-------------------|
| 34-079-SW-1 | 1.12 UJX | 18.2 | 2.57 U | 9.7 U | 6.83 U | 5.53 JX | 308  | 0.38 | 26.1 | 12.7 U | 6.24 J | 30.7 U | 11.7               | 82.8              |
| 34-079-SW-2 | 1.12 UJX | 20.7 | 2.57 U | 9.7 U | 6.83 U | 9.33 JX | 297  | 0.29 | 15.1 | 12.7 U | 5.48 J | 30.7 U | 49.2               | 102               |
| 34-079-SW-3 | 1.12 UJX | 22.2 | 2.57 U | 9.7 U | 7.73   | 23.4 JX | 1320 | 0.27 | 65.8 | 12.7 U | 89.8 J | 30.7 U | 430                | 127               |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 34-079-SW-1 | 115                    | 7        | 49      | < 0.05    | NR      |
| 34-079-SW-2 | 135                    | < 5.0    | 15      | < 0.05    | NR      |
| 34-079-SW-3 | 168                    | 7        | 25      | < 0.05    | NR      |

**LEGEND**

SE1 - Upgradient on Miller Creek. Approx. 75' upgradient from waste rock dump 2.

SW1 - Same as sample SE1.

SE2 - Downgradient of waste rock dump 2 on Miller Creek. Approx. 3' from confluence of adit discharge in creek.

SW2 - Same as sample SE2.

WR1 - Composite of subsamples WR1A, 1B, and 2.

SW3 - Adit discharge at waste rock dump 1.

BACKGROUND - From the Little Daisy Mine (34-009-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Upper Alice E.</u>                 | County: <u>Park</u>                        |
| Legal Description: <u>T 9S R 14E</u>                  | Section(s): <u>NW 1/4, SE 1/4, Sec. 24</u> |
| Mining District: <u>New World</u>                     | Mine Type: <u>Hardrock/Au</u>              |
| Latitude: <u>N 45° 01' 58"</u>                        | Primary Drainage: <u>Soda Butte Creek</u>  |
| Longitude: <u>W 109° 55' 38"</u>                      | USGS Code: <u>10070001</u>                 |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Miller Creek</u>    |
| Quad: <u>Cooke City</u>                               | Date Investigated: <u>August 10, 1993</u>  |
| Inspectors: <u>Babits, Flammang, Lasher</u>           | P.A. # <u>34-085</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no mill tailings associated with this site.
- There were approximately 6,600 cubic yards of uncovered waste rock on site. The following were elevated at least 3 times background:
  - Copper: 120 to 174 mg/kg
  - Iron: 81,800 mg/kg
  - Mercury: 0.215 to 0.651 mg/kg
  - Lead: 3,440 mg/kg
- There were no discharging adits at the site.
- There was no surface water at the site. The nearest surface water was approximately 200 feet away. No surface water or sediment samples were collected.
- There was one hazardous subsidence feature at the site.



**Upper Alice East PA# 34-085**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/10/93**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 34-085-WR-1 | 17.4 J        | 80.4          | 0.80          | 4.23          | 1.4 U         | 174           | 81800         | 0.651         | 45.2          | 3.51          | 252           | 6.29 UJ       | 104           | NR                 |
| 34-085-WR-2 | 41.6 J        | 80.1          | 0.59 U        | 3.07          | 12.3 J        | 120           | 46100         | 0.215         | 63.2          | 6.72          | 3440          | 7.04 UJ       | 68            | NR                 |
| BACKGROUND  | 14.6 J        | 89            | 0.4 U         | 10.5 J        | 30.7          | 40            | 23300         | 0.058 J       | 1450 J        | 20.7          | 158 J         | 5.17 U        | 181           | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL.<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|--------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 34-085-WR-1 | 11.3              | 354                                  | -3.11                          | -357                                      | 3.11                   | 2.65                   | 5.56                   | 82.8                                      | -85.9                                     |
| 34-085-WR-2 | 0.77              | 24.1                                 | -2.68                          | -26.7                                     | 0.53                   | 0.09                   | 0.15                   | 2.81                                      | -5.49                                     |

**LEGEND**

WR1 - Composite of subsamples WR1A, 1B, 1C, 1D, 2A, and 2B.  
 WR2 - Composite of subsamples WR3 and 4.  
 BACKGROUND - From the Little Daisy Mine (34-009-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Fisher Creek No. 1</u>             | County: <u>Park</u>                             |
| Legal Description: <u>T 9S R 15E</u>                  | Section(s): <u>NW 1/4, SW 1/4, Sec. 18</u>      |
| Mining District: <u>New World</u>                     | Mine Type: <u>Hardrock/Unknown</u>              |
| Latitude: <u>N 45° 02' 15"</u>                        | Primary Drainage: <u>Clark Fork Yellowstone</u> |
| Longitude: <u>W 109° 55' 11"</u>                      | <u>River</u>                                    |
| Land Status: <u>Public</u>                            | USGS Code: <u>10070006</u>                      |
| Quad: <u>Cooke City</u>                               | Secondary Drainage: <u>Fisher Creek</u>         |
| Inspectors: <u>Babits, Flammang, Lasher</u>           | Date Investigated: <u>August 10, 1993</u>       |
| Organization: <u>Pioneer Technical Services, Inc.</u> | P.A. # <u>34-090</u>                            |

- There were no mill tailings associate with this site.
- There were approximately 3,950 cubic yards of mostly uncovered waste rock on site. The following were elevated at least 3 times background:
  - Arsenic: 82.3J to 207J mg/kg
  - Barium: 228 to 333 mg/kg
  - Cadmium: 3.26 mg/kg
  - Copper: 255 to 449 mg/kg
  - Iron: 65,900 mg/kg
  - Mercury: 1.98 mg/kg
  - Lead: 213 to 920 mg/kg
  - Zinc: 732 mg/kg
- There were two discharging adits on site, and one enters Fisher Creek directly (SW-3); pH 6.95. Both discharges were sampled; the MCL for lead was exceeded in sample SW-3. Both discharges exceeded the acute and chronic fresh water aquatic criteria for copper.
- Fisher Creek was 1,300 feet from discharging adit SW-3. There was an observed release of mercury in the downstream sediments. No MCL/MCLGs were exceeded in downstream surface water. The chronic and acute fresh water aquatic life criteria for copper was exceeded in both the upstream and downstream surface water samples. The chronic fresh water aquatic life criteria was exceeded for lead in both upstream and downstream surface water samples, indicating an upstream source.
- There were three open adits at the site.

**Fisher Creek PA# 34-090**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/10/93**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 34-090-SE-1 | 16.3 J     | 104        | 0.76 U     | 17.6       | 19.8 J     | 1220       | 33900      | 0.092      | 885        | 21.2       | 59.6       | 9.12 UJ    | 159        | NR              |
| 34-090-SE-2 | 10.7 J     | 76.4       | 0.80 U     | 14.6       | 13.9 J     | 1020       | 24600      | 0.641      | 515        | 17.6       | 54.5       | 9.58 UJ    | 121        | NR              |
| 34-090-WR-1 | 207 J      | 228        | 3.26       | 3.07       | 1.17 U     | 449        | 65900      | 1.98       | 7.99       | 6.24       | 920        | 10.4 J     | 732        | NR              |
| 34-090-WR-2 | 82.3 J     | 333        | 0.49 U     | 15.4       | 19.2 J     | 255        | 32900      | 0.055      | 673        | 25.5       | 213        | 5.8 UJ     | 188        | NR              |
| BACKGROUND  | 8.61 J     | 71.7       | 0.9        | 12.4 J     | 27         | 66.9       | 17100      | 0.02 J     | 461 J      | 23.9       | 28.3 J     | 5.49 U     | 69.9 JX    | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID       | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|----------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 34-090-WR-1    | 6.64           | 207                            | -3.57                    | -211                             | 0.72             | 2.91             | 3.01             | 90.9                             | -94.5                            |
| 34-090-WR-2DUP | 0.27           | 8.43                           | 4.15                     | -4.29                            | 0.10             | 0.03             | 0.14             | 0.94                             | 3.21                             |
| 34-090-WR-2    | 0.25           | 7.81                           | 3.81                     | -4.00                            | 0.07             | 0.03             | 0.15             | 0.94                             | 2.88                             |

**WATER MATRIX ANALYSES**

**Metals in Water**  
**Results in ug/L**

| FIELD ID    | As      | Ba   | Cd     | Co    | Cr     | Cu      | Fe   | Hg     | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|---------|------|--------|-------|--------|---------|------|--------|------|--------|--------|--------|-----------------|----------------|
| 34-090-GW-1 | 4.48 JX | 40.6 | 2.57 U | 9.7 U | 6.83 U | 23.4 JX | 1610 | 0.27   | 102  | 12.7 U | 5.68 J | 30.7 U | 36.6            | 75.8           |
| 34-090-GW-2 | 6.44 JX | 38.5 | 2.67 J | 9.7 U | 6.83 U | 37 JX   | 2190 | 0.23   | 107  | 34.8 J | 9.21 J | 30.7 U | 65.9            | 67.2           |
| 34-090-SW-1 | 1.18 U  | 32.7 | 2.57 U | 9.7 U | 6.83 U | 180     | 655  | 0.27   | 112  | 12.7 U | 1.85 J | 30.7 U | 49.3            | 50.7           |
| 34-090-SW-2 | 1.18 U  | 34.6 | 2.57 U | 9.7 U | 6.83 U | 169     | 647  | 0.12 U | 102  | 12.7 U | 1.86 J | 30.7 U | 43              | 48.6           |
| 34-090-SW-3 | 6.5     | 102  | 2.57 U | 9.7 U | 6.83 U | 51.1    | 756  | 0.15   | 91.6 | 14.8   | 38.1 J | 30.7 U | 64              | 74.2           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Wet Chemistry**  
**Results in mg/l**

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 34-090-GW-1 | 110                    | 8        | 72      | 0.3       | NR      |
| 34-090-GW-2 | 112                    | 12       | 30      | 0.32      | NR      |
| 34-090-SW-1 | 89                     | 10       | 47      | 0.14      | NR      |
| 34-090-SW-2 | 88                     | 5        | 44      | < 0.05    | NR      |
| 34-090-SW-3 | 89                     | 5        | 17      | < 0.05    | NR      |

**LEGEND**

SE1 - Upgradient sediment sample in Fisher Creek.  
 SE2 - Downgradient sediment sample in Fisher Creek.  
 WR1 - Composite of subsamples WR1 and 2.  
 WR2 - Sample of the WR4 subsample.  
 BACKGROUND - From the Little Daisy Mine (34-009-SS-1).  
 WR2DUP - Duplicate of the 34-009-WR-2 sample.

GW1 - Groundwater in adit at waste rock dump 1.  
 GW2 - Duplicate of sample GW1.  
 SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.  
 SW3 - Adit discharge of waste rock dump 4.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Homestake No. 2</u>                | County: <u>Park</u>                                   |
| Legal Description: T <u>9S</u> R <u>14E</u>           | Section(s): <u>NE 1/4, NW 1/4, Sec. 14</u>            |
| Mining District: <u>New World</u>                     | Mine Type: <u>Hardrock/Cu, Au</u>                     |
| Latitude: <u>N 45° 03' 14"</u>                        | Primary Drainage: <u>Clark Fork Yellowstone River</u> |
| Longitude: <u>W 109° 56' 50"</u>                      | USGS Code: <u>10070006</u>                            |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Fisher Creek</u>               |
| Quad: <u>Cooke City</u>                               | Date Investigated: <u>August 9, 1993</u>              |
| Inspectors: <u>Bullock, Belanger, Clark</u>           | P.A. # <u>34-093</u>                                  |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no mill tailings observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 2,400 cubic yards. The following elements were elevated at least three times background:  
Iron: 61,200 mg/kg  
Manganese: 1490J mg/kg  
Mercury: 0.378J mg/kg
- There were no flowing adits, filled shafts, seeps, or springs associated with the site; consequently, no groundwater or surface water samples were collected during the investigation.
- The site was located approximately 1/2 mile above the Fisher Creek drainage with no direct runoff pathways from the waste rock to the Creek.
- There was one open adit, a highwall associated with an exploration trench and two structures identified as potential safety hazards at the site.



Homestake #2 PA# 34-093  
AMRB HAZARDOUS MATERIALS INVENTORY  
INVESTIGATOR: PIONEER - BULLOCK  
INVESTIGATION DATE: 08/09/93

**SOLID MATRIX ANALYSES**

**Metals in soils**  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 34-093-WR-1 | 16.7 J        | 71.7          | 0.6           | 10.3 J        | 21            | 1140          | 61200         | 0.378 J       | 1490 J        | 23.1          | 79.8 J        | 6.35 U        | 162           | NR                 |
| BACKGROUND  | 8.61 J        | 71.7          | 0.9           | 12.4 J        | 27            | 66.9          | 17100         | 0.02 J        | 461 J         | 23.9          | 28.3 J        | 5.49 U        | 69.9 JX       | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|----------------------|---|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 34-093-WR-1 | 1.01                 | 31.6                                    | 29.0                          | -2.52                                     | 0.02                   | 0.32                   | 0.67                   | 10.0                                      | 19.0                                      |

**LEGEND**

WR1 - Composite of subsamples WR1A, 1B, and 1C.  
BACKGROUND - From the Lower Glengarry (34-006-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Charter Oak  
Legal Description: T 9N R 7W  
Mining District: Elliston  
Latitude: N 46° 29' 25"  
Longitude: W 112° 25' 10"  
Land Status: Private/Public  
Quad: Bison Mountain  
Inspectors: Bullock, Babits, Flammang, Clark,  
Lasher/Pierson  
Organization: Pioneer Tech. Services//TD&H

County: Powell  
Section(s): SW 1/4, NE 1/4, Sec. 36  
Mine Type: Hardrock/Pb, Zn, Cu, Ag, Au  
Primary Drainage: Little Blackfoot River  
USGS Code: 17010201  
Secondary Drainage: Little Blackfoot River  
Date Investigated: June 11, 1993  
P.A. # 39-003

- The volume of tailings associated with this site was estimated to be approximately 6,000 cubic yards. The tailings extended out into a wetlands associated with the Little Blackfoot River. The following elements were at least three times background:

|                                   |                            |
|-----------------------------------|----------------------------|
| Arsenic: 14,500 to 63,700 mg/kg   | Cadmium: 61J mg/kg         |
| Copper: 198 to 318 mg/kg          | Iron: 111,000 mg/kg        |
| Mercury: 0.365JX to 0.375JX mg/kg | Lead: 3670 to 18,200 mg/kg |
| Antimony: 131J to 843J mg/kg      | Zinc: 314J to 6650J mg/kg  |
- The volume of waste rock associated with this site was estimated to be approximately 19,000 cubic yards. The following elements were elevated at least three times background:

|                               |                                   |
|-------------------------------|-----------------------------------|
| Arsenic: 2650 to 13,500 mg/kg | Cadmium: 1.8J to 2.0J mg/kg       |
| Copper: 144 mg/kg             | Mercury: 0.329JX to 0.984JX mg/kg |
| Lead: 4100 to 12,300 mg/kg    | Antimony: 71J to 284J mg/kg       |
| Zinc: 244J mg/kg              |                                   |
- Two discharging adits were associated with this site. The lower, and more recently worked adit discharged approximately 10 to 15 gpm, at a pH of 2.4 to 2.5 and a specific conductance of 2380 to 3030 umhos/cm. Total arsenic concentrations in this discharge range from 24,100 to 41,900 ug/l. A dissolved arsenic sample concentration was measured at 16,100 ug/l. This discharge exceeded MCL/MCLGs for arsenic, cadmium, copper, and antimony. This discharge also exceeded aquatic life criteria for these metals and zinc. The upper adit discharge was comparatively benign with a neutral pH, no MCL/MCLG exceedances, and only exceeded the acute aquatic life criteria for iron.
- The Little Blackfoot River flowed adjacent to the site. No observed releases to the river were documented during this investigation, however, cyanide was elevated in the discharge from the wetlands to the river.
- There were several barrels of chemicals, solvents, and liquids present on the site.
- A domestic water supply well within one mile downgradient of the site had a slightly elevated arsenic concentration (10.9 ug/l), but well below the MCL of 50 ug/l.

**Charter Oak PA# 39-003**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/11/93**

**SOLID MATRIX ANALYSES**

| Metals in soils |       | Results per dry weight basis, mg/kg |       |       |      |      |        |          |        |     |       |       |        |         |
|-----------------|-------|-------------------------------------|-------|-------|------|------|--------|----------|--------|-----|-------|-------|--------|---------|
| FIELD ID        | As    | Ba                                  | Cd    | Co    | Cr   | Cu   | Fe     | Hg       | Mn     | Ni  | Pb    | Sb    | Zn     | CYANIDE |
| 39-003-SE-1     | 44    | 26.2                                | 1.6 J | 4.9   | 13.9 | 8.1  | 10300  | 0.026 JX | 199 J  | 8   | 31    | 5 UJ  | 261 J  | 0.16    |
| 39-003-SE-2     | 107   | 44.7                                | 0.6 U | 6     | 17.5 | 12.1 | 14600  | 0.032 JX | 291 J  | 13  | 74    | 5 J   | 156 J  | NR      |
| 39-003-SE-3     | 81    | 66                                  | 0.5 U | 5.8   | 15.8 | 10.7 | 14000  | 0.025 JX | 397 J  | 8   | 82    | 5 J   | 150 J  | NR      |
| 39-003-TP-1     | 14500 | 54                                  | 1.7 J | 2.7   | 7.5  | 198  | 48700  | 0.375 JX | 71.3 J | 2 U | 3670  | 131 J | 314 J  | NR      |
| 39-003-TP-2     | 63700 | 22.4                                | 61 J  | 9.7   | 1.8  | 318  | 111000 | 0.365 JX | 30.5 J | 2 U | 18200 | 843 J | 6650 J | NR      |
| 39-003-WR-1     | 2650  | 62.6                                | 1.8 J | 1.2 U | 2.4  | 34.8 | 27000  | 0.361 JX | 124 J  | 2 U | 1960  | 71 J  | 244 J  | NR      |
| 39-003-WR-2     | 13500 | 55.2                                | 1 J   | 1.2 U | 1.6  | 144  | 26700  | 0.984 JX | 28.3 J | 2 U | 12300 | 113 J | 233 J  | NR      |
| 39-003-WR-3     | 2930  | 20.4                                | 2 J   | 1.3   | 5    | 50.3 | 34200  | 0.329 JX | 142 J  | 3   | 4100  | 284 J | 72 J   | NR      |
| BACKGROUND      | 163   | 147                                 | 0.6 U | 9.2   | 9.3  | 21.7 | 35800  | 0.066 JX | 933 J  | 9   | 30    | 8 J   | 78 J   | NR      |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID       | TOTAL SULFUR |           | NEUTRAL. POTENT. |         | SULFUR ACID BASE POTENT. |         | SULFATE |      | PYRITIC |         | ORGANIC |   | PYRITIC   |         | SULFUR    |         |
|----------------|--------------|-----------|------------------|---------|--------------------------|---------|---------|------|---------|---------|---------|---|-----------|---------|-----------|---------|
|                | TOTAL        | ACID BASE | POTENT.          | POTENT. | ACID BASE                | POTENT. | SULFUR  | %    | SULFUR  | %       | SULFUR  | % | ACID BASE | POTENT. | ACID BASE | POTENT. |
|                | %            | 1/1000t   | 1/1000t          | 1/1000t | 1/1000t                  | 1/1000t | %       | %    | 1/1000t | 1/1000t | %       | % | 1/1000t   | 1/1000t | %         | %       |
| 39-003-TP-1    | 2.97         | 92.8      | -7.8             | -101    | 0.54                     | 1.98    | 0.45    | 61.9 | -69.7   |         |         |   |           |         |           |         |
| 39-003-TP-2    | 13.8         | 430       | -5.9             | -436    | 0.79                     | 6.25    | 6.72    | 195  | -201    |         |         |   |           |         |           |         |
| 39-003-WR-1    | 1.8          | 56.2      | -1.5             | -58     | 1.73                     | <0.01   | 0.07    | 0    | -1.52   |         |         |   |           |         |           |         |
| 39-003-WR-2    | 1.01         | 31.6      | -3.5             | -35     | 0.86                     | <0.01   | 0.15    | 0    | -3.5    |         |         |   |           |         |           |         |
| 39-003-WR-3    | 5.06         | 158       | -3.3             | -161    | 0.2                      | 3.14    | 1.72    | 98.1 | -101    |         |         |   |           |         |           |         |
| 39-003-WR-3DUP | 5.08         | 159       | -4               | -163    | 0.24                     | 3.14    | 1.7     | 98.1 | -102    |         |         |   |           |         |           |         |

**LEGEND**

SED1 - At PPE.  
 SED2 - Downstream of PPE on Little Blackfoot River.  
 SED3 - Upstream of PPE on Little Blackfoot River.  
 TP1 - Composite of subsamples TP1A, 2A, and 3.  
 TP2 - Composite of subsamples TP1C, 1E, and 2C.  
 WR1 - Composite of subsamples WR1, 4, and 5.  
 WR2 - Composite of subsamples WR2A and 2B.  
 WR3 - Composite of subsamples WR3, 6, 7, 8, and 9.  
 BACKGROUND - From the Charter Oak Mine (39-003-SS-1).  
 WR3DUP - Duplicate of sample 39-003-WR-3.

**WATER MATRIX ANALYSES**

| Metals in Water  |        | Results in ug/L |        |        |        |        |        |         |       |        |        |        |         |              | Hardness Calc. |  |
|------------------|--------|-----------------|--------|--------|--------|--------|--------|---------|-------|--------|--------|--------|---------|--------------|----------------|--|
| FIELD ID         | As     | Ba              | Cd     | Co     | Cr     | Cu     | Fe     | Hg      | Mn    | Ni     | Pb     | Sb     | Zn      | (mg CaCO3/L) |                |  |
| 39-003-GW-1(TM)  | 41900  | 10              | 140    | 40.1   | 5 U    | 2370   | 233000 | 0.12 J  | 2610  | 33.3   | 440 J  | 148    | 14500   | 406          |                |  |
| 39-003-GW-1A(DM) | 16100  | 10.2            | 73.1   | 18.8   | 6.83 U | 1180 J | 120000 | 0.13 J  | 1930  | 18.3 J | 127 J  | 30.7 U | 8160 J  | 400          |                |  |
| 39-003-GW1A(TM)  | 24100  | 10.5            | 97.5   | 25.1   | 6.83 U | 1520 J | 162000 | 0.12 U  | 2350  | 19.2 J | 256 J  | 42.5   | 10500 J | 419          |                |  |
| 39-003-GW-2(TM)  | 196    | 9.13            | 2.55 U | 5.99 U | 5 U    | 1.35 U | 3270   | 0.11 J  | 2290  | 8.78 U | 1.31 J | 18.3 U | 421     | 593          |                |  |
| 39-003-GW-3(TM)  | 10.9 J | 5.37            | 2.57 U | 9.7 U  | 6.83 U | 3.23 J | 128    | 0.181   | 6.87  | 12.7 U | 1.57   | 30.7 U | 50      | 53.7         |                |  |
| 39-003-GW-3(DM)  | 8.73 J | 4.8             | 2.57 U | 9.7 U  | 6.83 U | 3.3 J  | 100    | 0.118 U | 9.8   | 12.7 U | 0.72 U | 30.7 U | 68.3    | 52.5         |                |  |
| 39-003-SW-1(TM)  | 20.1   | 7.3             | 2.55 U | 5.99 U | 5 U    | 1.5    | 182    | 0.077 J | 31.4  | 8.78 U | 2.18 J | 18.3 U | 46.4    | 72.9         |                |  |
| 39-003-SW-2(TM)  | 10.4   | 2.24 U          | 2.55 U | 5.99 U | 5 U    | 1.35 U | 154    | 0.11 J  | 2.6 U | 8.78 U | 2.16 J | 18.3 U | 6 U     | 44.3         |                |  |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Wet Chemistry**

**Results in mg/l**

| Field I.D.  | TOTAL DISSOLVED SOLIDS |           | CHLORIDE |         | SULFATE   |         | NO3/NO2-N |  | CYANIDE |  |
|-------------|------------------------|-----------|----------|---------|-----------|---------|-----------|--|---------|--|
|             | TOTAL                  | DISSOLVED | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |           |  |         |  |
| 39-003-GW-1 | 1720                   | <         | 5.0      | 1020    | <         | 0.05    | NR        |  |         |  |
| 39-003-GW-2 | 804                    | <         | 5.0      | 363     | <         | 0.05    | NR        |  |         |  |
| 39-003-SW-1 | 113                    | <         | 5.0      | 33      | <         | 0.05    | 0.02      |  |         |  |
| 39-003-SW-2 | 95                     | <         | 5.0      | 21      | <         | 0.05    | NR        |  |         |  |

**LEGEND**

GW1(TM) - Adit discharge associated with waste rock dump 9, Total metals.  
 GW1A(DM) - Same location, yet filtered and sampled for dissolved metals.  
 GW1A(TM) - Same location, sampled for total metals.  
 GW2(TM) - Adit directly above old mill building - total metals.  
 GW3(TM) - Well at Sunshine Kiawanas camp - total metals.  
 GW3(DM) - Same location, yet filtered and sampled for dissolved metals.  
 SW1(TM) - PPE - Beaver pond discharge - total metals.  
 SW2 - Background and water quality sample - total metals.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Lily/Orphan Boy</u>                | County: <u>Powell</u>                         |
| Legal Description: <u>T 8N R 6W</u>                   | Section(s): <u>NE 1/4, SW 1/4, Sec. 15</u>    |
| Mining District: <u>Elliston</u>                      | Mine Type: <u>Hardrock/Au, Pb, Zn, Ag, Cu</u> |
| Latitude: <u>N 46° 26' 34"</u>                        | Primary Drainage: <u>Telegraph Creek</u>      |
| Longitude: <u>W 112° 20' 27"</u>                      | USGS Code: <u>17010201</u>                    |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Telegraph Creek</u>    |
| Quad: <u>Three Brothers</u>                           | Date Investigated: <u>June 28, 1993</u>       |
| Inspectors: <u>Bullock, Flammang, Clark</u>           | P.A. # <u>39-006</u>                          |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be 2600 cubic yards. The following elements were elevated at least three times background:

|                                 |                          |
|---------------------------------|--------------------------|
| Arsenic: 13,000 to 21,500 mg/kg | Cadmium: 5.9 mg/kg       |
| Copper: 125 mg/kg               | Iron: 71,800 mg/kg       |
| Mercury: 0.289J to 0.861J mg/kg | Lead: 9720 to 9850 mg/kg |
| Antimony: 164J to 254J mg/kg    | Zinc: 612 mg/kg          |
- The waste rock dumps were unvegetated and WR-2 was being undercut and eroded by Telegraph Creek.
- A discharging adit (GW-1) was present, with a flow of 15 gpm, a pH of 3.36, and a specific conductance of 910 umhos/cm. The adit discharge exceeded MCL/MCLGs for arsenic, cadmium, and antimony. Acute aquatic life criteria were exceeded for arsenic, cadmium, copper, lead, and zinc and chronic aquatic life standards were exceeded for arsenic, cadmium, copper, iron, lead and zinc.
- Telegraph Creek was in contact with part of Waste Rock 2. The stream sampling was conducted during a storm runoff event. Water samples from the creek documented observed releases of arsenic, cadmium, copper, iron, lead, and zinc, as well as an exceedance of the MCL/MCLG for cadmium. The acute aquatic life criteria for copper and the chronic aquatic life criteria for iron were exceeded and directly attributable to the site. Stream sediment samples also documented releases of arsenic, cadmium, copper, iron, mercury, lead, antimony, and zinc.
- The shaft associated with Waste Rock 1 was a hazardous mine opening and has been grouted by MDSL.



**Lily/Orphan Boy PA# 39-006**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/28/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 39-006-SE-1 | 4450       | 283        | 38.4       | 118        | 4.1 U      | 440        | 61800      | 0.106 J    | 14200      | 86         | 550        | 15 UJ      | 1200       | NR              |
| 39-006-SE-2 | 104        | 62.8       | 0.5 U      | 15.5       | 3.5        | 11.5       | 18300      | 0.018 U    | 1570       | 13         | 65         | 4 UJ       | 164        | NR              |
| 39-006-WR-1 | 13000      | 43.7       | 5.9        | 7          | 1.9        | 78.3       | 29900      | 0.861 J    | 1310       | 9          | 9720       | 254 J      | 612        | NR              |
| 39-006-WR-2 | 21500      | 15.1       | 0.4 U      | 11.2       | 1.7        | 125        | 71800      | 0.289 J    | 43         | 1 U        | 9850       | 164 J      | 251        | NR              |
| BACKGROUND  | 88         | 61         | 1.2 J      | 6.9        | 5.4        | 32.7       | 18500      | 0.017 JX   | 1220 J     | 10         | 62         | 5 J        | 133 J      | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 39-006-WR-1 | 1.78           | 55.6                           | -1.3                    | -57                              | 0.49             | 0.56             | 0.73             | 17.5                             | -18.8                            |
| 39-006-WR-2 | 8.55           | 267                            | -5.7                    | -273                             | 0.54             | 5.61             | 2.4              | 175                              | -181                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co      | Cr   | Cu   | Fe    | Hg      | Mn   | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|------|--------|---------|------|------|-------|---------|------|--------|------|--------|-----------------|----------------|
| 39-006-GW-1 | 881  | 14.5 | 342 J  | 42.1 JX | 5 U  | 620  | 19200 | 0.038 U | 5410 | 32.6   | 398  | 36.7   | 22500           | 132            |
| 39-006-SW-1 | 20.5 | 15.7 | 7.3 J  | 7.33 JX | 7.93 | 11.7 | 1900  | 0.038 U | 226  | 11     | 4.77 | 18.3 U | 635             | 16.8           |
| 39-006-SW-2 | 4.3  | 8.87 | 2.55 U | 5.99 UX | 7    | 1.57 | 552   | 0.042   | 41.5 | 8.78 U | 1.38 | 18.3 U | 23.4            | 11             |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 39-006-GW-1 | 470                    | < 5.0    | 282     | < 0.05    | NR      |
| 39-006-SW-1 | 83                     | < 5.0    | 16      | < 0.05    | NR      |
| 39-006-SW-2 | 69                     | < 5.0    | 8       | < 0.05    | NR      |

**LEGEND**

SE1 - Downstream of waste rock dump 2 approx. 200'  
SE2 - Upstream of pond behind waste rock dump 2.  
WR1 - Composite of subsamples WR1A, 1B, 1C, and 1D.  
WR2 - Composite of subsamples WR2A, 2B, and 2C.  
BACKGROUND - From the Ontario Millsite (39-010-SS-1).

GW1 - Collapsed adit #1.  
SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Monarch</u>                        | County: <u>Powell</u>                           |
| Legal Description: <u>T 8N R 6W</u>                   | Section(s): <u>NE 1/4, NW 1/4, Sec. 31</u>      |
| Mining District: <u>Elliston</u>                      | Mine Type: <u>Hardrock/Au, Ag</u>               |
| Latitude: <u>N 46° 24' 27"</u>                        | Primary Drainage: <u>Little Blackfoot River</u> |
| Longitude: <u>W 112° 24' 12"</u>                      | USGS Code: <u>17010201</u>                      |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Monarch Creek</u>        |
| Quad: <u>Bison Mountain</u>                           | Date Investigated: <u>August 18, 1993</u>       |
| Inspectors: <u>Bullock, Belanger</u>                  | P.A. # <u>39-008</u>                            |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no mill tailings observed at this site during the investigation. The claim holder was in the process of assembling a small-scale mill but had not achieved production at the time of this investigation.
- The volume of waste rock associated with the site was estimated to be approximately 4,200 cubic yards. The following elements were elevated at least three times background:

|                      |                        |
|----------------------|------------------------|
| Arsenic: 163J mg/kg  | Copper: 727J mg/kg     |
| Mercury: 1.85J mg/kg | Manganese: 4240J mg/kg |
| Lead: 469J mg/kg     | Antimony: 195 mg/kg    |
- One discharging adit was observed at the site during the investigation. No MCLs were exceeded in the adit discharge; however, the chronic aquatic life criteria for mercury was exceeded. The discharge had a pH measurement of 9.0 and a specific conductance of 780 umhos/cm. After flowing adjacent to the waste rock dump for its entire length, the discharge had a pH measurement of 8.26 and a specific conductance of 180 umhos/cm.
- One potentially hazardous adit opening was identified at the site, as well as one potentially hazardous structure.

**Monarch PA# 39-008**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/18/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 39-008-WR-1 | 163 J      | 40 J       | 3.3        | 8.49       | 2.85       | 727 J      | 42100 J    | 1.85 J     | 4240 J     | 3.49       | 469 J      | 195        | 109 J      | NR              |
| BACKGROUND  | 22.6 J     | 141 J      | 1.4        | 7.17       | 8.13       | 18.9 J     | 16600 J    | 0.043 J    | 835 J      | 5.56       | 37 J       | 6.78 U     | 90.9 J     | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 39-008-WR-1 | 1              | 31.2                           | 6.19                     | -25                              | 0.44             | 0.31             | 0.25             | 9.68                             | -3.5                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co    | Cr     | Cu     | Fe   | Hg     | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|------|--------|-------|--------|--------|------|--------|------|--------|--------|--------|-----------------|----------------|
| 39-008-GW-1 | 4.21 | 19.6 | 2.57 U | 9.7 U | 6.83 U | 1.67 J | 46.7 | 0.19 J | 41.6 | 12.7 U | 2.19 J | 30.7 U | 38.5 J          | 115            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 39-008-GW-1 | 167                    | < 5.0    | 133     | < 0.05    | NR      |

**LEGEND**

WR1 - Composite of subsamples WR1A, 1B, 1C, and 1D.  
BACKGROUND - From the Monarch Mine (39-008-SS-1).

GW1 - Discharge from adit associated with waste rock dump 1.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Ontario Millsite</u>   | County: <u>Powell</u>                           |
| Legal Description: <u>T 8N R 6W</u>   | Section(s): <u>NE 1/4, SW 1/4, Sec. 22</u>      |
| Mining District: <u>Elliston</u>  | Mine Type: <u>Hardrock/Pb, Zn, Cu, Ag, Au</u>   |
| Latitude: <u>N 46° 25' 45"</u>  | Primary Drainage: <u>Little Blackfoot River</u> |
| Longitude: <u>W 112° 15' 00"</u>  | USGS Code: <u>17010201</u>                      |
| Land Status: <u>Private/Public</u>  | Secondary Drainage: <u>Ontario Creek</u>        |
| Quad: <u>Three Brothers</u>   | Date Investigated: <u>June 10, 1993</u>         |
| Inspectors: <u>Babits, Bullock, Flammang, Clark, Lasher/Pierson</u>                   | P.A. # <u>39-010</u>                            |
| Organization: <u>Pioneer Technical Services, Inc./ Thomas, Dean and Hoskins, Inc.</u> |   |

- The volume of tailings associated with this site was estimated to be approximately 2,500 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 1,510 to 2,730 mg/kg      Lead: 1,290 to 2,090 mg/kg  
Cadmium: 13.8J to 30.7J mg/kg      Antimony: 55J to 130J mg/kg  
Copper: 178 to 628 mg/kg      Zinc: 1,770 to 2,530 mg/kg  
Mercury: 0.085JX to 0.113JX mg/kg
- The volume of waste rock associated with this site was estimated to be approximately 25,750 cubic yards. The following elements were elevated at least three times background (based on XRF analyses):  
Arsenic: 905 mg/kg      Lead: 393 to 1,396 mg/kg  
Barium: 454 to 701 mg/kg
- Two discharging adits (collapsed) were observed at the site during the investigation. MCLs were exceeded for arsenic, cadmium, and antimony in the Adit #1 discharge. Acute and chronic aquatic life criteria were exceeded for arsenic, cadmium, copper, lead, and zinc, and chronic aquatic life criteria were exceeded for iron and mercury in the Adit #1 discharge. Acute and chronic aquatic life criteria were exceeded for cadmium, copper, and zinc, and chronic aquatic life criteria were exceeded for iron and mercury in the Adit #2 discharge. Adit discharge pH measurements were 2.3 and 3.6 for Adit #1 and Adit #2, respectively.
- Ontario Creek was flowing near the site and received the discharge from Adit #2. Observed releases to Ontario Creek were documented for copper and zinc in water samples, and arsenic, copper, lead and antimony in sediment samples; however, no MCLs or acute or chronic aquatic life criteria were exceeded in Ontario Creek that were attributable to the site. The upstream surface water sample indicated the presence of an upgradient contaminant source.
- A potentially hazardous collapsing building was observed at the site.



**Ontario Millsite PA# 39-010**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 06/10/93**

**SOLID MATRIX ANALYSES**

| FIELD ID    | Metals in soils |            | Results per dry weight basis |            |            |            |            |            |            |            |            |            |            |                 |
|-------------|-----------------|------------|------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
|             | As (mg/Kg)      | Ba (mg/Kg) | Cd (mg/Kg)                   | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 39-010-SE-1 | 851             | 26.7       | 1.8 J                        | 8.5        | 2.9        | 60.7       | 8060       | 0.034 JX   | 544 J      | 4          | 337        | 18 J       | 150 J      | NR              |
| 39-010-SE-2 | 3420            | 17.4       | 0.5 U                        | 1.3 U      | 2.5        | 52.1       | 25000      | 0.114 JX   | 19.9 J     | 2          | 2080       | 128 J      | 273 J      | NR              |
| 39-010-SE-4 | 12              | 26.7       | 0.6 U                        | 8          | 1.8        | 9.3        | 8410       | 0.031 JX   | 269 J      | 3          | 12         | 4 UJ       | 62 J       | NR              |
| 39-010-TP-1 | 1790            | 41.1       | 30.7 J                       | 4          | 4          | 628        | 7560       | 0.085 JX   | 74.4 J     | 9          | 1410       | 61 J       | 2530 J     | NR              |
| 39-010-TP-2 | 2730            | 8.5        | 13.8 J                       | 1.2        | 1 U        | 178        | 6930       | 0.113 JX   | 22.2 J     | 2 U        | 1290       | 130 J      | 1770 J     | NR              |
| 39-010-TP-5 | 1510            | 5.8        | 0.4 U                        | 1 U        | 0.9        | 47.4       | 3550       | 0.093 JX   | 4.3 J      | 2 U        | 2090       | 55 J       | 76 J       | NR              |
| BACKGROUND  | 88              | 61         | 1.2 J                        | 6.9        | 5.4        | 32.7       | 18500      | 0.017 JX   | 1220 J     | 10         | 62         | 5 J        | 133 J      | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
|             |                |                                |                         |                                  |                  |                  |                  |                                  |                                  |
| 39-010-TP-1 | 1.35           | 42.2                           | -6.1                    | -48                              | <0.01            | 0.13             | 1.22             | 4.06                             | -10.2                            |
| 39-010-TP-2 | 0.52           | 16.2                           | -1.7                    | -18                              | 0.12             | 0.05             | 0.35             | 1.56                             | -3.29                            |
| 39-010-TP-5 | 0.1            | 3.12                           | 0.09                    | -3                               | 0.07             | <0.01            | 0.03             | 0                                | 0.09                             |

**WATER MATRIX ANALYSES**

| FIELD ID    | Metals in Water |      | Results in ug/L |        |     |        |       |         |      |        |        |        |      |      | HARDNESS CALC. Zn (mg CaCO3/L) |
|-------------|-----------------|------|-----------------|--------|-----|--------|-------|---------|------|--------|--------|--------|------|------|--------------------------------|
|             | As              | Ba   | Cd              | Co     | Cr  | Cu     | Fe    | Hg      | Mn   | Ni     | Pb     | Sb     |      |      |                                |
| 39-010-GW-1 | 1190            | 9.27 | 35              | 33     | 5 U | 306    | 44300 | 0.053 J | 2100 | 21.3   | 425 J  | 29.5   | 5310 | 82.1 |                                |
| 39-010-GW-2 | 20.3            | 14.6 | 3.9             | 15.2   | 6   | 12.4   | 6420  | 0.11 J  | 1170 | 8.78 U | 2.79 J | 18.3 U | 768  | 58.5 |                                |
| 39-010-SW-1 | 5.4             | 6.27 | 2.55 U          | 5.99 U | 5 U | 5.67   | 177   | 0.093 J | 44.4 | 8.78 U | 5.5 J  | 18.3 U | 75   | 8    |                                |
| 39-010-SW-2 | 11.3            | 14   | 8.6             | 14.6   | 5 U | 92     | 480   | 0.099 J | 1160 | 8.78 U | 153 J  | 18.3 U | 1690 | 47   |                                |
| 39-010-SW-4 | 2.87            | 6.73 | 2.55 U          | 5.99 U | 5 U | 1.35 U | 198   | 0.1 J   | 8.1  | 8.78 U | 2.7 J  | 18.3 U | 7.4  | 7    |                                |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Wet Chemistry**

**Results in mg/l**

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
|             |                        |          |         |           |         |
| 39-010-GW-1 | 48                     | < 5.0    | 220     | < 0.05    | NR      |
| 39-010-GW-2 | 204                    | < 5.0    | 92      | < 0.05    | NR      |
| 39-010-SW-1 | 302                    | < 5.0    | 10      | < 0.05    | NR      |
| 39-010-SW-2 | 186                    | < 5.0    | 83      | < 0.05    | NR      |
| 39-010-SW-4 | 46                     | < 5.0    | 8       | < 0.05    | NR      |

**LEGEND**

SE1 - Downgradient of TP5 & majority of streambank tailings on Ontario Creek.  
 SE2 - Downgradient of furthest downgradient tailings impoundment (TP4).  
 SE4 - Upstream of confluence with tailings in Ontario Creek.  
 TP1 - Composite of subsamples TP 1B, 2AC, and 4AD.  
 TP2 - Composite of subsamples TP1A, 2AA, 2AB, and 4AA through 4AC.  
 TP5 - Grab of subsample TP5A.  
 BACKGROUND - From the Ontario Millsite (39-010-SS-1).  
 GW1 - Adit furthest North, by waste rock dump 1.  
 GW2 - Adit furthest South, by waste rock dump 2.  
 SW1 - Same as sample SE1.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Golden Anchor</u>                  | County: <u>Powell</u>                             |
| Legal Description: <u>T 8N R 7W</u>                   | Section(s): <u>NE 1/4, SW 1/4, Sec. 1</u>         |
| Mining District: <u>Elliston</u>                      | Mine Type: <u>Hardrock/Unknown</u>                |
| Latitude: <u>N 46° 28' 20"</u>                        | Primary Drainage: <u>Little Blackfoot River</u>   |
| Longitude: <u>W 112° 25' 27"</u>                      | USGS Code: <u>17010201</u>                        |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Little Blackfoot River</u> |
| Quad: <u>Bison Mountain</u>                           | Date Investigated: <u>July 14, 1993</u>           |
| Inspectors: <u>Bullock, Flammang, Clark</u>           | P.A. # <u>39-012</u>                              |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be 5000 cubic yards. The following elements were elevated at least three times background:  
Cadmium: 3.1J mg/kg                      Antimony: 29J mg/kg  
Zinc: 329J mg/kg.
- The waste rock dumps were mostly unvegetated.
- A discharging adit, sampled as GW-1, was present, with a flow of approximately 1.4 gpm, a pH of 6.85, and a specific conductance of 188.7 umhos/cm. The adit discharge exceeded the MCL for arsenic, the acute aquatic life criteria for zinc and the chronic aquatic life criteria for iron, mercury, and zinc.
- An unnamed tributary to the Little Blackfoot River flowed past the northern boundary of the site. There were no observed releases, MCL/MCLG or aquatic life criteria exceedances attributable to this site. Samples were collected during a storm event which visibly intensified between the downstream and upstream sample collection. This storm event may be partially responsible for inconclusive results generated by this sampling.
- Two highwalls were present and classified as hazardous; one approximately 25 feet high and associated with collapsed Adit #1, and the second approximately one half mile above the adit in an exploration cut that was about 50 feet high. A metal building in poor repair was also classified as potentially hazardous.

**Golden Anchor PA# 39-012**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/14/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 39-012-SE-1 | 247 J      | 69         | 6.6 J      | 19.2       | 1.7        | 8.6 JX     | 12200      | 0.084 J    | 1910       | 3 UJX      | 137 J      | 7 J        | 643 J      | NR              |
| 39-012-SE-2 | 697 J      | 69.7       | 7 J        | 12.8       | 2.7        | 19.4 JX    | 20800      | 0.131 J    | 1200       | 4 UJX      | 454 J      | 12 J       | 726 J      | NR              |
| 39-012-WR-1 | 323 J      | 379        | 3.1 J      | 3.3        | 3.9        | 17.2 JX    | 13500      | 0.074 J    | 310        | 2 UJX      | 80 J       | 29 J       | 329 J      | NR              |
| BACKGROUND  | 163        | 147        | 0.6 U      | 9.2        | 9.3        | 21.7       | 35800      | 0.066 JX   | 933 J      | 9          | 30         | 8 J        | 78 J       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 39-012-WR-1 | 2.84           | 88.7                           | 52.6                    | -36                              | 1                | 1.3              | 0.54             | 40.6                             | 12                               |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba    | Cd     | Co     | Cr     | Cu     | Fe   | Hg    | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|-------|--------|--------|--------|--------|------|-------|--------|--------|--------|--------|-----------------|----------------|
| 39-012-GW-1 | 61.6 | 10.40 | 2.57 U | 9.70 U | 6.83 U | 1.55 U | 3610 | 0.260 | 953 J  | 12.7 U | 1.42 J | 30.7 U | 208 J           | 80.9           |
| 39-012-SW-1 | 30.6 | 5.87  | 2.57 U | 9.70 U | 6.83 U | 1.55 U | 188  | 0.230 | 58.5 J | 12.7 U | 1.85 J | 30.7 U | 183 J           | 69             |
| 39-012-SW-2 | 27.9 | 6.77  | 2.57 U | 9.70 U | 6.83 U | 23.10  | 154  | 0.094 | 18.4 J | 12.7 U | 2.19 J | 30.7 U | 152 J           | 65.4           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 39-012-GW-1 | 201                    | 6.3      | 55      | < 0.05    | NR      |
| 39-012-SW-1 | 271                    | < 5.0    | 58      | < 0.05    | NR      |
| 39-012-SW-2 | 151                    | < 5.0    | 57      | < 0.05    | NR      |

**LEGEND**

SE1 - Downstream of waste rock dump 1.  
SE2 - Above access road to mine approx. 40'.  
WR1 - Composite of subsamples WR1A, 1B, and 1C.  
BACKGROUND - From the Charter Oak (39-003-SS-1).

GW1 - At the mouth adit #1.  
SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Hard Luck</u>                      | County: <u>Powell</u>                         |
| Legal Description: <u>T 8N R 6W</u>                   | Section(s): <u>NW 1/4, SW 1/4, Sec. 21</u>    |
| Mining District: <u>Elliston</u>                      | Mine Type: <u>Hardrock/Ag, Zn, Pb, Cu, Au</u> |
| Latitude: <u>N 46° 25' 43"</u>                        | Primary Drainage: <u>Ontario Creek</u>        |
| Longitude: <u>W 112° 22' 12"</u>                      | USGS Code: <u>17010201</u>                    |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Ontario Creek</u>      |
| Quad: <u>Three Brothers</u>                           | Date Investigated: <u>July 14, 1993</u>       |
| Inspectors: <u>Tuesday, Belanger, Lasher</u>          | P.A. # <u>39-014</u>                          |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no mill tailings observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 650 cubic yards. The following elements were elevated at least three times background:

|                                 |                             |
|---------------------------------|-----------------------------|
| Arsenic: 4290J to 3750J mg/kg   | Cadmium: 6J mg/kg           |
| Mercury: 0.061J to 0.391J mg/kg | Manganese: 26,500 mg/kg     |
| Lead: 16,500 J mg/kg            | Antimony: 15J to 314J mg/kg |
| Zinc: 492J mg/kg                |                             |
- One adit discharge was observed at the site during the investigation. The minor flow was discharged from the open adit through a 2-inch pipe around a waste dump, to a wooden bucket and eventually seeped into the ground. No MCLs were exceeded in the adit discharge; however, the acute aquatic life criteria for cadmium and the chronic aquatic life criteria for mercury were exceeded. No other surface water was observed in the vicinity of the site.
- Two potentially hazardous mine openings were observed during the investigation including one partially caved adit and one partially caved shaft, and a potentially hazardous collapsing building was located on the west side of the site.



**Hard Luck PA# 39-014**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 07/14/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 39-014-WR-1 | 3750 J     | 16.7       | 6 J        | 9.6        | 1.9        | 13.3 JX    | 52400      | 0.061 J    | 26500      | 7 JX       | 151 J      | 15 J       | 492 J      | NR              |
| 39-014-WR-2 | 4290 J     | 70.2       | 3.3 J      | 1.5 U      | 1.1 U      | 55.1 JX    | 17300      | 0.391 J    | 8.1        | 2 UJX      | 16500 J    | 314 J      | 97 J       | NR              |
| BACKGROUND  | 88         | 61         | 1.2 J      | 6.9        | 5.4        | 32.7       | 18500      | 0.017 JX   | 1220 J     | 10         | 62         | 5 J        | 133 J      | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 39-014-WR-1 | 1.6            | 50                             | 119                      | 69.3                             | 0.44             | 0.87             | 0.29             | 27.2                             | 92.1                             |
| 39-014-WR-2 | 0.76           | 23.7                           | -0.3                     | -24                              | 0.72             | 0.01             | 0.03             | 0.31                             | -0.65                            |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba     | Cd     | Co     | Cr     | Cu     | Fe   | Hg      | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|--------|--------|--------|--------|--------|------|---------|--------|--------|--------|--------|-----------------|----------------|
| 39-014-GW-1 | 31.7 J | 2.01 U | 2.57 U | 9.70 U | 6.83 U | 1.55 U | 23.7 | 0.038 U | 4.08 U | 12.7 U | 0.72 U | 30.7 U | 7.57 U          | 62.8           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 39-014-GW-1 | 116                    | < 5.0    | 24      | < 0.05    | NR      |

**LEGEND**

WR1 - Composite of subsamples WR1A and 1B.  
WR2 - Composite of subsamples WR3A and 3B.  
BACKGROUND - From the Ontario Millsite (39-010-SS-1).

GW1 - Adit discharge.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Kimball</u>  | County: <u>Powell</u>                             |
| Legal Description: <u>T 8N R 7W</u>   | Section(s): <u>NW 1/4, NE 1/4, Sec. 12</u>        |
| Mining District: <u>Elliston</u>  | Mine Type: <u>Hardrock/Pb, Ag, Au, Zn, Cu</u>     |
| Latitude: <u>N46° 27' 49"</u>   | Primary Drainage: <u>Little Blackfoot River</u>   |
| Longitude: <u>W 112° 25' 04"</u>  | USGS Code: <u>17010201</u>                        |
| Land Status: <u>Public</u>  | Secondary Drainage: <u>Little Blackfoot River</u> |
| Quad: <u>Bison Mountain</u>   | Date Investigated: <u>August 18, 1993</u>         |
| Inspectors: <u>Bullock, Belanger/Pierson</u>  | P.A. # <u>39-018</u>                              |
| Organization: <u>Pioneer Technical Services, Inc./ Thomas, Dean and Hoskins, Inc.</u> |   |

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be 6500 cubic yards. The following elements were elevated at least three times background:

|                      |                    |
|----------------------|--------------------|
| Arsenic: 2350J mg/kg | Cadmium: 5.6 mg/kg |
| Antimony: 97.6 mg/kg | Zinc: 385J mg/kg   |
| Lead: 901J mg/kg     |                    |
- The waste rock was 90% unvegetated.
- No discharging adits, seeps, or springs were observed during the investigation.
- No surface water samples were collected due to an absence of direct runoff pathways to the nearest surface water.
- The adit associated with Waste Rock 3 had a culvert closure installed by the MDSL.
- An old loadout present on the site was classified as a potential hazardous structure.

Kimball PA# 39-018  
AMRB HAZARDOUS MATERIALS INVENTORY  
INVESTIGATOR: PIONEER - BULLOCK  
INVESTIGATION DATE: 08/18/93

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 39-018-WR-1 | 2350 J        | 66.6 J        | 5.6           | 3.91          | 4.47          | 32.2 J        | 38600 J       | 0.064 J       | 412 J         | 2.64 U        | 901 J         | 97.6          | 385 J         | NR                 |
| BACKGROUND  | 163           | 147           | 0.6 U         | 9.2           | 9.3           | 21.7          | 35800         | 0.066 JX      | 933 J         | 9             | 30            | 8 J           | 78 J          | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL.<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|----------------------|---|--------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 39-018-WR-1 | 3.07                 | 95.9                                    | 43.4                           | -53                                       | 0.65                   | 2.09                   | 0.33                   | 65.3                                      | -21.9                                     |

**LEGEND**

WR1 - Composite of subsamples WR1, 2A, 2B, and 3.  
BACKGROUND - From Charter Oak Mine (39-003-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Sure Thing</u><br>Legal Description: <u>T 8N R 6W</u><br>Mining District: <u>Elliston</u><br>Latitude: <u>N 46° 26' 23"</u><br>Longitude: <u>W 112° 19' 55"</u><br>Land Status: <u>Private/Public</u><br>Quad: <u>Three Brothers</u><br>Inspectors: <u>Bullock, Flammang, Clark</u><br>Organization: <u>Pioneer Technical Services, Inc.</u> | County: <u>Powell</u><br>Section(s): <u>NW 1/4, SE 1/4, Sec. 15</u><br>Mine Type: <u>Hardrock/Au, Ag, Cu, Pb, Zn</u><br>Primary Drainage: <u>Telegraph Creek</u><br>USGS Code: <u>17010201</u><br>Secondary Drainage: <u>O'Keefe Creek</u><br>Date Investigated: <u>June 28, 1993</u><br>P.A. # <u>39-020</u> |
|---|---|

- There were no mill tailings associated with this site.
  
- The volume of waste rock associated with this site was estimated to be 7700 cubic yards. The following elements were elevated at least three times background:

|                               |                     |
|-------------------------------|---------------------|
| Arsenic: 2810-4930 mg/kg      | Cobalt: 57.3 mg/kg  |
| Mercury : 0.149J-0.285J mg/kg | Nickel: 57 mg/kg    |
| Copper: 129-248 mg/kg         | Iron: 123,000 mg/kg |
| Antimony: 35J-42J mg/kg       | Zinc: 556 mg/kg     |
  
- The waste rock dump(WR-2) had elevated radiation readings ranging from 0.15-0.7 mR/hr.
  
- One discharging adit had a small flow of 3 gpm. The discharge, sampled as GW-1, had a pH of 3.36, and a specific conductance of 990 umhos/cm. The sample exceeded MCL/MCLGs for antimony, arsenic, cadmium, and copper, exceeded aquatic life standards (chronic) for iron, cadmium, copper, lead, and zinc, and aquatic life standards (acute) for cadmium, copper, lead, and zinc.
  
- Seeps were located below the Sure Thing Mine site, associated with mine workings that were not originally inventoried under this PA number also had low pH's ranging from 3.71 to 5.34.
  
- The hazardous highwall associated with the collapsed adit was 20 feet high.



**Sure Thing PA# 39-020**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/28/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 39-020-WR-1 | 2810       | 9.6        | 0.6 U      | 1.3 U      | 1.7        | 54.8       | 12000      | 0.149 J    | 16.5       | 2 U        | 3850       | 42 J       | 43         | NR              |
| 39-020-WR-2 | 4460       | 11.7       | 0.5 U      | 57.3       | 1 U        | 129        | 123000     | 0.285 J    | 6.8        | 57         | 24000      | 35 J       | 166        | NR              |
| 39-020-WR-3 | 4930       | 22.9       | 0.5 U      | 3.1        | 4.9        | 248        | 54100      | 0.18 J     | 151        | 3          | 1620       | 13 J       | 556        | NR              |
| BACKGROUND  | 88         | 61         | 1.2 J      | 6.9        | 5.4        | 32.7       | 18500      | 0.017 JX   | 1220 J     | 10         | 62         | 5 J        | 133 J      | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 39-020-WR-1 | 0.47           | 14.7                           | -0.8                     | -15                              | 0.16             | 0.13             | 0.18             | 4.06                             | -4.82                            |
| 39-020-WR-2 | 17.7           | 554                            | -4.5                     | -558                             | 2.08             | 7.92             | 7.72             | 247                              | -252                             |
| 39-020-WR-3 | 1.54           | 48.1                           | -7.4                     | -56                              | 1.24             | 0.05             | 0.25             | 1.56                             | -8.97                            |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd    | Co      | Cr  | Cu   | Fe    | Hg      | Mn    | Ni   | Pb  | Sb   | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|------|-------|---------|-----|------|-------|---------|-------|------|-----|------|-----------------|----------------|
| 39-020-GW-1 | 1740 | 4.57 | 101 J | 61.2 JX | 7.8 | 1360 | 29400 | 0.038 U | 12800 | 52.7 | 183 | 25.5 | 11000           | 114            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD I.D.  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 39-020-GW-1 | 490                    | < 5.0    | 286     | < 0.05    | NR      |

**LEGEND**

WR1 - Composite of subsamples WR1A, 1B, and 1C.  
 WR2 - Sample of the WR2A subsample.  
 WR3 - Composite of the subsamples WR2B and 2C.  
 BACKGROUND - From the Ontario Millsite (39-010-SS-1).

GW1 - Discharge from adit #1.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |   |
|--|---|
| Mine/Site Name: <u>Julia</u>   | County: <u>Powell</u>                     |
| Legal Description: <u>T 8N R 6W</u>  | Section(s): <u>S 1/2, SW 1/4, Sec. 5</u>  |
| Mining District: <u>Elliston</u>   | Mine Type: <u>Hardrock/Cu, Pb, Au, Ag</u> |
| Latitude: <u>N 46° 28' 00"</u>   | Primary Drainage: <u>Telegraph Creek</u>  |
| Longitude: <u>W 112° 22' 35"</u>   | USGS Code: <u>17010201</u>                |
| Land Status: <u>Public</u>   | Secondary Drainage: <u>Booth Gulch</u>    |
| Quad: <u>Bison Mountain and Three Brothers</u>                                       | Date Investigated: <u>June 28, 1993</u>   |
| Inspectors: <u>Babits, Lasher/Pierson</u>  | P.A. # <u>39-022</u>                      |
| Organization: <u>Pioneer Technical Services, Inc./Thomas, Dean and Hoskins, Inc.</u> |   |

- There were no mill tailings associated with this site.
- There were approximately 10,720 cubic yards of uncovered waste rock on site. The following were elevated at least 3 times background:
  - Cadmium: 3.9 to 291 mg/kg
  - Copper: 108 to 155 mg/kg
  - Mercury: 1.37J to 5.12J mg/kg
  - Lead: 2,030 to 10,500 mg/kg
  - Antimony: 382J to 602J mg/kg
- There were no discharging adits at this site.
- There was no surface water on the site. The nearest surface water is 0.5 miles away.
- There was one open adit and two hazardous loadout structures on site.

Julia PA# 39-022  
AMRB HAZARDOUS MATERIALS INVENTORY  
INVESTIGATOR: PIONEER - BABITS  
INVESTIGATION DATE: 06/28/93

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 39-022-WR-1 | 106           | 17.8          | 3.9           | 2.3           | 1.2           | 108           | 25000         | 1.37 J        | 67.2          | 2 U           | 2030          | 382 J         | 458           | NR                 |
| 39-022-WR-2 | 136           | 5.8           | 291           | 8.6           | 1.1 U         | 155           | 90500         | 5.12 J        | 16.7          | 4             | 10500         | 602 J         | 27600         | NR                 |
| BACKGROUND  | 163           | 147           | 0.6 U         | 9.2           | 9.3           | 21.7          | 35800         | 0.066 JX      | 933 J         | 9             | 30            | 8 J           | 78 J          | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR<br>% | TOTAL SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|-------------------|--------------------------------------|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 39-022-WR-1 | 1.77              | 55.3                                 | -1.9                          | -57                                       | 1.24                   | 0.12                   | 0.41                   | 3.75                                      | -5.66                                     |
| 39-022-WR-2 | 17.2              | 537                                  | -3.5                          | -540                                      | <0.01                  | 6.96                   | 10.9                   | 217                                       | -221                                      |

**LEGEND**

WR1 - Composite of subsamples WR1A, 1B, 1C, and 3.  
WR2 - Sample from the WR2 subsample.  
BACKGROUND - From Charter Oak Mine (39-003-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Telegraph</u>  | County: <u>Powell</u>                      |
| Legal Description: T <u>8N</u> R <u>6W</u>  | Section(s): <u>NW 1/4, NE 1/4, Sec. 11</u> |
| Mining District: <u>Elliston</u>  | Mine Type: <u>Hardrock, Placer/Au, Ag</u>  |
| Latitude: <u>N 46° 27' 51"</u>  | Primary Drainage: <u>Telegraph Creek</u>   |
| Longitude: <u>W 112° 18' 51"</u>  | USGS Code: <u>17010201</u>                 |
| Land Status: <u>Private/Public</u>  | Secondary Drainage: <u>Bryan Creek</u>     |
| Quad: <u>Three Brothers</u>   | Date Investigated: <u>June 10, 1993</u>    |
| Inspectors: <u>Bullock/Pierson</u>  | P.A. # <u>39-023</u>                       |
| Organization: <u>Pioneer Technical Services,<br/>Inc./ Thomas, Dean and Hoskins, Inc.</u> |  |

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be 1260 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 524J mg/kg                      Copper: 99.2 mg/kg  
Mercury: 0.147 to 0.506 mg/kg              Lead: 425 mg/kg
- The waste rock dumps were unvegetated.
- Two discharging adits were present, GW-1 had a flow of 5 gpm, a pH of 4.77, and specific conductance of 135.3 umhos/cm. The second adit (GW-2) had a flow of 8 gpm, a neutral pH of 6.53, and a low specific conductance of 36 umhos/cm. Both adit discharges empty into Bryan Creek below the site. One seep was also located between WR-3 and WR-4.
- The discharge flowed over the waste rock at the site and then into Bryan Creek south of the mine. An observed release of copper was documented in the surface water. MCL/MCLGs were not exceeded in Bryan Creek. Although, there were several aquatic life criteria exceedances in the Bryan Creek samples, none were directly attributed to this site.
- Two hazardous structures were present at the site, an old loadout or mill, and a cabin. There was a highwall present behind adit #1 and WR-1 was over-steepened and eroding into the adit discharge.



**Telegraph PA# 39-023**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/10/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 39-023-SE-1 | 58 J       | 91.9       | 10.1       | 7.7        | 6.3        | 54.2       | 14300      | 0.217      | 2080       | 17 J       | 62         | 6 J        | 913        | NR              |
| 39-023-SE-2 | 57 J       | 112        | 19.6       | 5.3        | 5.9        | 70.3       | 13000      | 0.131      | 3080       | 23 J       | 40         | 4 UJ       | 1840       | NR              |
| 39-023-WR-1 | 208 J      | 48         | 0.4 UJ     | 1.3        | 4.3        | 48.9       | 25500      | 0.506      | 24.2       | 1 UJ       | 425        | 3 UJ       | 47         | NR              |
| 39-023-WR-2 | 524 J      | 23.8       | 0.5 UJ     | 1.1 U      | 1.9        | 99.2       | 27500      | 0.147      | 24.1       | 2 UJ       | 58         | 8 J        | 133        | NR              |
| BACKGROUND  | 88         | 61         | 1.2 J      | 6.9        | 5.4        | 32.7       | 18500      | 0.017 JX   | 1220 J     | 10         | 62         | 5 J        | 133 J      | NR              |

U - Not Detected, J - Estimated Quantity, X - Outlier for Accuracy or Precision, NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 39-023-WR-1 | 0.35           | 10.9                           | -0.1                    | -11                              | 0.34             | <0.01            | 0.01             | 0                                | -0.05                            |
| 39-023-WR-2 | 0.44           | 13.7                           | -4.1                    | -18                              | 0.43             | <0.01            | 0.01             | 0                                | -4.14                            |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co     | Cr  | Cu   | Fe  | Hg     | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|--------|--------|-----|------|-----|--------|------|--------|--------|--------|-----------------|----------------|
| 39-023-SW-1 | 2.9    | 13.9 | 4.5    | 5.99 U | 5 U | 8.43 | 142 | 0.14   | 40.5 | 8.78 U | 3.6    | 18.3 U | 726             | 15.2           |
| 39-023-SW-2 | 1.49 U | 14.4 | 4.07   | 5.99 U | 5 U | 4.57 | 107 | 0.1 J  | 62.2 | 8.78 U | 2.39 J | 18.3 U | 1090            | 16.6           |
| 39-023-SW-3 | 2.84   | 16.3 | 2.55 U | 5.99 U | 5 U | 34.2 | 166 | 0.11 J | 103  | 8.78 U | 6.17 J | 18.3 U | 76.8            | 13.3           |
| 39-023-SW-4 | 1.87   | 15.4 | 2.55 U | 5.99 U | 5 U | 17.7 | 329 | 0.07 J | 129  | 8.78 U | 1.9 J  | 18.3 U | 80.5            | 20             |

U - Not Detected, J - Estimated Quantity, X - Outlier for Accuracy or Precision, NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 39-023-SW-1 | 55                     | < 5.0    | 19      | 0.07      | NR      |
| 39-023-SW-2 | 54                     | < 5.0    | 18      | 0.06      | NR      |
| 39-023-SW-3 | 69                     | < 5.0    | 28      | < 0.05    | NR      |
| 39-023-SW-4 | 72                     | < 5.0    | 26      | < 0.05    | NR      |

**LEGEND**

SE1 - Bryan Creek downstream from adit discharge confluence.

SE2 - Bryan Creek upstream from adit discharge and possible influence from waste rock dump 2.

WR1 - Composite of subsamples WR1A, 1B, and 1C.

WR2 - Sample of the WR2 subsample.

BACKGROUND - From the Ontario Millsite (39-010-SS-1).

SW1 - Same as sample SE1.

SW2 - Same as sample SE2.

SW3 - Adit discharge below waste rock dump 1.

SW4 - Confluence of seeps in adit #1 area on the N. side of the road.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Third Term</u>                     | County: <u>Powell</u>                         |
| Legal Description: T <u>9N</u> R <u>6W</u>            | Section(s): <u>NE 1/4, SE 1/4, Sec. 28</u>    |
| Mining District: <u>Elliston</u>                      | Mine Type: <u>Hardrock/Zn, Cu, Pb, Au, Ag</u> |
| Latitude: <u>N 46° 30' 08"</u>                        | Primary Drainage: <u>Little Blackfoot</u>     |
| Longitude: <u>W 112° 21' 09"</u>                      | USGS Code: <u>17010201</u>                    |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Flume Creek</u>        |
| Quad: <u>Mac Donald Pass</u>                          | Date Investigated: <u>July 14, 1993</u>       |
| Inspectors: <u>Tuesday, Belanger, Lasher</u>          | P.A. # <u>39-024</u>                          |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no mill tailings observed at this site during the investigation.
- The volume of waste rock associated with the site was estimated to be approximately 2,700 cubic yards. The dumps were previously reclaimed. The following elements were elevated at least three times background:  
Copper: 116JX mg/kg                      Lead: 200J mg/kg
- There were no adit discharges, filled shafts, seeps, or springs observed at the site during the investigation.
- Little Flume Gulch flowed from east to west approximately eight feet south of the toe of WR-1. No MCLs were exceeded in Little Flume Gulch in either the upstream or downstream water samples; however, the chronic aquatic life criteria for mercury and lead were exceeded in both the upstream and downstream samples. The acute and chronic aquatic life criteria were exceeded for copper and zinc in the downstream sample.
- Observed releases to Little Flume Gulch were documented for copper and zinc. The aquatic life criteria exceedances for copper and zinc were directly attributed to the site.

**Third Term PA# 39-024**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 07/14/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 39-024-SE-1 | 51 J       | 199        | 3.6 J      | 24.9       | 8.9        | 23.6 JX    | 25500      | 0.107 J    | 3680       | 9 JX       | 20 J       | 9 UJ       | 132 J      | NR              |
| 39-024-SE-2 | 23 J       | 116        | 9.8 J      | 28.2       | 3.5        | 169 JX     | 11100      | 0.072 J    | 3300       | 11 JX      | 13 J       | 6 UJ       | 405 J      | NR              |
| 39-024-WR-1 | 29 J       | 93.7       | 2.8 J      | 6.3        | 83.2       | 116 JX     | 28400      | 0.12 J     | 281        | 42 JX      | 200 J      | 10 J       | 128 J      | NR              |
| BACKGROUND  | 20 J       | 180        | 1.9 J      | 8.2        | 39.2       | 29 JX      | 15900      | 0.067 J    | 588        | 19 JX      | 28 J       | 6 UJ       | 123 J      | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| BACKGROUND  | 0.02           | 0.62                           | 4.49                    | 3.86                             | 0.01             | 0.01             | <0.01            | 0.31                             | 4.18                             |
| 39-024-WR-1 | 0.9            | 28.1                           | 201                     | 173                              | 0.53             | 0.16             | 0.21             | 5                                | 196                              |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba    | Cd     | Co     | Cr     | Cu    | Fe  | Hg    | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|-------|--------|--------|--------|-------|-----|-------|--------|--------|--------|--------|-----------------|----------------|
| 39-024-SW-1 | 6.90 | 9.30  | 2.57 U | 9.70 U | 6.83 U | 24.50 | 628 | 0.240 | 58.5 J | 12.7 U | 1.25 J | 30.7 U | 89.1 J          | 25.2           |
| 39-024-SW-2 | 6.11 | 14.30 | 2.57 U | 9.70 U | 6.83 U | 1.67  | 598 | 0.210 | 32.5 J | 12.7 U | 1.22 J | 30.7 U | 7.57 U          | 24.5           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 39-024-SW-1 | 92                     | < 5.0    | 10      | < 0.05    | NR      |
| 39-024-SW-2 | 87                     | < 5.0    | 8       | < 0.05    | NR      |

**LEGEND**

SE1 - Downstream of dump in Little Flume Gulch.

SW1 - Same as sample SE1.

SE2 - Upstream from dump in Little Flume Gulch.

SW2 - Same as sample SE2.

WR1 - Composite of WR1A and 1B.

BACKGROUND - West of subsample WR1B, From the Third Term (39-024-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Anna R./Hattie M.</u>              | County: <u>Powell</u>                              |
| Legal Description: <u>T 8N R 6W</u>                   | Section(s): <u>NE 1/4, NE 1/4, NW 1/4, Sec. 15</u> |
| Mining District: <u>Elliston</u>                      | Mine Type: <u>Hardrock/Au</u>                      |
| Latitude: <u>N 46° 27' 04"</u>                        | Primary Drainage: <u>Little Blackfoot River</u>    |
| Longitude: <u>W 112° 20' 27"</u>                      | USGS Code: <u>17010201</u>                         |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Telegraph Creek</u>         |
| Quad: <u>Three Brothers</u>                           | Date Investigated: <u>June 28, 1993</u>            |
| Inspectors: <u>Babits, Lasher/Pierson</u>             | P.A. # <u>39-044</u>                               |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no mill tailings associated with this site.
- There were approximately 2,230 cubic yards of uncovered waste rock at the site. The following were elevated at least three times background:

|                                 |                          |
|---------------------------------|--------------------------|
| Arsenic: 3,540 to 10,400 mg/kg  | Cadmium: 5.9 mg/kg       |
| Cobalt: 28.6 mg/kg              | Copper: 167 to 343 mg/kg |
| Mercury: 0.195J to 0.721J mg/kg | Nickel: 37 mg/kg         |
| Lead: 2,030 to 5,980 mg/kg      | Antimony: 38J mg/kg      |
| Zinc: 673 mg/kg                 |                          |
- There was one discharging adit at the site, but it did not enter surface water directly. A sample of this discharge had a pH of 5.73, and the MCL/MCLG for cadmium was exceeded.
- There was no surface water on the site. The nearest surface water was 500 feet away.
- There was one open shaft, one hazardous loadout structure, and one collapsing cabin (mill) at the site.



**Anna R./Hattie M. PA# 39-044**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 06/28/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 39-044-WR-1 | 3540       | 25.1       | 5.9        | 28.6       | 2.4        | 343        | 27000      | 0.721 J    | 5840       | 37         | 2030       | 14 J       | 673        | NR              |
| 39-044-WR-2 | 10400      | 18.5       | 0.5 U      | 4.1        | 1 U        | 167        | 54900      | 0.195 J    | 63.3       | 4          | 5980       | 38 J       | 272        | NR              |
| BACKGROUND  | 88         | 61         | 1.2 J      | 6.9        | 5.4        | 32.7       | 18500      | 0.017 JX   | 1220 J     | 10         | 62         | 5 J        | 133 J      | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 39-044-WR-1 | 0.57           | 17.8                           | 1.37                     | -16                              | 0.36             | 0.05             | 0.16             | 1.56                             | -0.19                            |
| 39-044-WR-2 | 2.53           | 79                             | -11                      | -90                              | 0.73             | 1.22             | 0.58             | 38.1                             | -48.8                            |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co      | Cr  | Cu | Fe   | Hg      | Mn  | Ni   | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|------|--------|---------|-----|----|------|---------|-----|------|------|--------|-----------------|----------------|
| 39-044-SW-1 | 40.2 | 2.67 | 6.93 J | 11.9 JX | 5 U | 64 | 1390 | 0.038 U | 630 | 10.4 | 12.5 | 18.3 U | 810             | 57.3           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 39-044-SW-1 | 145                    | < 5.0    | 49      | 0.15      | NR      |

**LEGEND**

WR1 - Composite of subsamples WR1A, 1B, and 3B.  
 WR2 - Composite of subsamples WR2A, 2B, and 3A.  
 BACKGROUND - From Ontario Millsite (39-010-SS-1).

SW1 - Adit discharge from waste rock dump 1.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Mountain View</u>                  | County: <u>Powell</u>                           |
| Legal Description: T <u>8N</u> R <u>6W</u>            | Section(s): <u>SW 1/4, NW 1/4, Sec. 6</u>       |
| Mining District: <u>Elliston</u>                      | Mine Type: <u>Hardrock/Pb, Ag, Au</u>           |
| Latitude: <u>N 46° 28' 26"</u>                        | Primary Drainage: <u>Little Blackfoot River</u> |
| Longitude: <u>W 112° 24' 20"</u>                      | USGS Code: <u>17010201</u>                      |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Unnamed Tributary</u>    |
| Quad: <u>Bison Mountain</u>                           | Date Investigated: <u>July 14, 1993</u>         |
| Inspectors: <u>Bullock, Flammang, Clark</u>           | P.A. # <u>39-062</u>                            |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no tailings directly associated with this site. Approximately 10 cubic yards of tailings were found to be associated with a mine west of the Mountain View.
- The volume of waste rock associated with this site was estimated to be 6500 cubic yards. The following elements were elevated at least three times background:

|                       |                      |
|-----------------------|----------------------|
| Arsenic: 706J mg/kg   | Cadmium: 12.4J mg/kg |
| Mercury: 0.177J mg/kg | Antimony: 41J mg/kg  |
| Lead: 687J mg/kg      | Zinc: 1870J mg/kg    |
- The waste rock dumps were mostly unvegetated.
- The adit associated with Waste Rock 1, sampled as GW-1, was discharging at approximately 5 gpm, had a pH of 6.81, and a specific conductance of 2050 umhos/cm. This sample exceeded the MCL/MCLGs for arsenic, and antimony, as well as the acute aquatic life criteria for zinc and the chronic aquatic life criteria for iron, and zinc.
- A seep at the toe of WR-1 was the start of the flow in the unnamed tributary to the Little Blackfoot River. This seep had a pH of 6.68 and a specific conductance of 205 umhos/cm.
- The unnamed tributary was sampled as SW-1 below Waste Rock 2. The stream had a flow rate of approximately 30 gpm, a pH of 6.87, and a specific conductance of 187.8 umhos/cm. This sample exceeded the MCL for arsenic, as well as the acute aquatic life criteria for cadmium and zinc, and the chronic aquatic life criteria for cadmium, lead, and zinc. Arsenic, cadmium, copper, mercury, lead, antimony and zinc were detected in the stream sediment sample collected at this location higher than three times background for the area.
- The discharging adit at WR-1 was open and classified as potentially hazardous. Water was ponded behind a berm pushed up in front of the adit opening.

**Mountain View PA# 39-062**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 07/14/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 39-062-SE-1 | 4390 J     | 105        | 74.4 J     | 16.8       | 3.8        | 194 JX     | 75800      | 0.195 J    | 2400       | 5 UJX      | 1700 J     | 49 J       | 11500 J    | NR              |
| 39-062-WR-1 | 706 J      | 31         | 12.4 J     | 9.8        | 3          | 46.2 JX    | 28300      | 0.177 J    | 1130       | 3 JX       | 687 J      | 41 J       | 1870 J     | NR              |
| BACKGROUND  | 163        | 147        | 0.6 U      | 9.2        | 9.3        | 21.7       | 35800      | 0.066 JX   | 933 J      | 9          | 30         | 8 J        | 78 J       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 39-062-WR-1 | 2.97           | 92.8                           | 52.9                     | -40                              | 0.98             | 1.24             | 0.75             | 38.7                             | 14.2                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co     | Cr     | Cu     | Fe   | Hg      | Mn   | Ni     | Pb     | Sb     | Zn  | HARDNESS CALC. (mg CaCO3/L) |
|-------------|--------|------|--------|--------|--------|--------|------|---------|------|--------|--------|--------|-----|-----------------------------|
| 39-062-GW-1 | 149 J  | 9.57 | 2.57 U | 9.70 U | 6.83 U | 1.55 U | 1660 | 0.038 U | 928  | 12.7 U | 1.37 J | 31.1   | 132 | 111                         |
| 39-062-SW-1 | 92.6 J | 5.10 | 4.70 J | 9.70 U | 6.83 U | 1.55 U | 190  | 0.038 U | 23.1 | 12.7 U | 4.31 J | 30.7 U | 931 | 116                         |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 39-062-GW-1 | 222                    | < 5.0    | 58      | < 0.05    | NR      |
| 39-062-SW-1 | 204                    | < 5.0    | 65      | < 0.05    | NR      |

**LEGEND**

SE1 - Just downstream of waste rock dump 2.  
 WR1 - Composite of subsamples WR1A, 1B, 2A, and 2B.  
 BACKGROUND - From the Charter Oak Mine (39-003-SS-1).

GW1 - At the mouth of adit #1.  
 SW1 - Same as sample SE1.

**Open Pit Mining** - A form of operation designed to extract minerals that lie near the surface.

**Open Stope Method** - Stoping in which no regular artificial method of support is employed, although occasional props or cribs may be used to hold local patches of insecure ground. Usually confined to relatively small, narrow ore bodies.

**Ore** - A mineral, or mineral aggregate, containing precious or useful metals, and which occurs in such quantity, grade, and chemical combination as to make extraction commercially profitable.

**Ore Bin** - A receptacle for ore awaiting treatment or shipment, also referred to as a loadout.

**Ore Body** - A solid and fairly continuous mass of ore, which may include low-grade ore and waste as well as high-grade material.

**Ore Deposit** - A general term applied to rocks containing minerals of economic value in such amount that they can be profitably tracted.

**Oxidation/Reduction Potential** - The hypothetical electron activity at equilibrium. A measurement of the relative tendency (potential) of a solution to accept or transfer electrons, measured in volts.

**PA No.** - Problem Area Number established by the DSL-AMRB.

**Perennial stream** - A stream or stretch of a stream that flows continuously throughout the year.

**pH** - A measure of the degree of acidity or basicity of a solution. At 25° C, a pH of 7 is neutral. Acidity increases as measurements decrease below 7, and basicity increases as measurements increase above 7.

**Placer** - A mineral concentration resulting from weathering processes, usually involving water. Placer deposits are typically composed of heavy minerals, with gold, platinum, tin, and diamonds being the most important.

**Ponded** - A condition in which free water covers the soil surface, as in a closed depression.

**Portal** - (1) The surface entrance to a drift, tunnel, or adit; (2) The entrance to a mine.

**Pregnant Solution** - Metal-laden solution (cyanide, acid, etc.) resulting from a leach process.

**Primary Drainage** - The primary drainage is the smallest named stream segment/drainage basin that is locatable on the USGS Hydrologic Unit Map within which the mine site is located.

**Prospect** - (1) A mineral property, the value of which has not been proved by exploration. (2) Non-producing mining property under development or considered worthy of such attention.

**PRP** - Potentially Responsible Party.

**Pulp** - A mixture of ground ore and water capable of flowing through suitably graded channels as a fluid.



**QA - Quality Assurance**

**QC - Quality Control**

**Raise** - A vertical or inclined opening driven upward from a level to connect with the level above, or to explore the ground for a limited distance above one level.

**Reagent** - A chemical or solution used to produce a desired chemical reaction; a substance used in assay or flotation.

**Rod Mill** - A mill for fine grinding, employing long steel rods to grind the material.

**Secondary Drainage** - The secondary drainage is the smallest named stream segment/drainage that is locatable on the USGS Quadrangle Map within which the mine site is located.

**Sediment** - Solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water, or ice and has come to rest on the earth's surface either above or below the water level.

**Sedimentation** - The settling of solid particles of soil, coal, or mineral from liquid as a result of gravity or centrifuging.

**Shaft** - An excavation of limited area compared with its depth, made for access to underground mine workings.

**Sluice (Sluice Box)** - A long trough-like box set at an incline of about 1:20 through which placer gravel is carried by a stream of water. The gravel is washed away while most of the gold or other heavy materials are caught by riffles or blankets on the floor of the sluice.

**Slurry** - Fine solid particles suspended in a liquid, typically water, of a consistency that allows flow by gravity or pumping.

**Source** - Any area where a hazardous substance has been deposited, stored, disposed, or placed, plus those soils that have become contaminated from migration of a hazardous substance.

**Specific Conductance** - The specific conductance or conductivity of water (or other substance measured) is the electrical conductance of the material between opposite sides of a cube 1 centimeter in each direction.

**Stamp Mill** - An apparatus in which rock is crushed by a stamp battery.

**Stope** - An underground excavation from which ore has been removed.

**Subsidence** - A sinking down of a part of the earth's surface due to the collapse of underlying underground openings.

**Surface Mining** - The mining in surface excavations, including placer mining, mining in open pits, mining and removing ore from open cuts by hand or with mechanical excavating and transportation equipment, and the removal of overburden to uncover the ore.

**Tailing Pond** - A pond with a constraining wall or dam to which mill effluents are run.

**Tailings** - The refuse material resulting from the washing, concentration, or treatment of ground ore.

**Tunnel** - A horizontal or nearly horizontal underground passage that is open to the atmosphere at both ends.

**USFS** - United States Department of Agriculture, Forest Service.

**USGS** - United States Department of Interior, Geological Survey.

**Waste** - The rock that is too low in grade to be of economic value.

**Waste Dump (Spoil Pile)** - The area where mine wastes or spoil materials are discarded.

**Wetlands** - Areas that under normal circumstances have hydrophytic vegetation, hydric marshes, and wetland hydrology. It includes landscape units such as bogs, marshes, and lowlands covered with shallow ephemeral or intermittent waters. Permanent waters of streams and water deeper than 9 feet in lakes or reservoirs are not considered wetlands.

**Winze** - A vertical or inclined opening, or excavation, connecting two levels in a mine, differing from a raise only in construction. A winze is driven downward and a raise is excavated upward.

**X-ray Fluorescence (XRF) Spectrometer** - Instrument used for metals analysis of solid media by energy dispersive X-ray fluorescence.



**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Viking</u>   | County: <u>Powell</u>                     |
| Legal Description: <u>T 8N R 6W</u>   | Section(s): <u>NE 1/4, NE 1/4, Sec. 5</u> |
| Mining District: <u>Elliston</u>  | Mine Type: <u>Hardrock/Au</u>             |
| Latitude: <u>N 46° 27' 47"</u>  | Primary Drainage: <u>Telegraph Creek</u>  |
| Longitude: <u>W 112° 22' 30"</u>  | USGS Code: <u>17010201</u>                |
| Land Status: <u>Public</u>  | Secondary Drainage: <u>Booth Gulch</u>    |
| Quad: <u>Three Brothers and Bison Mountain</u>  | Date Investigated: <u>August 18, 1993</u> |
| Inspectors: <u>Bullock, Belanger/Pierson</u>  | P.A. # <u>39-077</u>                      |
| Organization: <u>Pioneer Technical Services,<br/>Inc./ Thomas, Dean and Hoskins, Inc.</u> |   |

- Site was a former cyanide heap leach facility which had been graded out and reseeded. At the time of this investigation approximately 50% of the area had revegetated.
- The volume of waste material formerly associated with the leach pad was estimated to be 2000 cubic yards. The following elements were elevated at least three times background:

|                     |                       |
|---------------------|-----------------------|
| Arsenic: 719J mg/kg | Cadmium: 2.4J mg/kg   |
| Copper: 128JX mg/kg | Lead: 586J-796J mg/kg |
| Zinc: 604JX mg/kg   |                       |
- Cyanide was also detected at 0.564 mg/kg
- No discharging adits, seeps or springs were observed. A sediment retention pond had been installed below the northern adit waste rock pile.
- It was approximately 1/3 mile to the nearest surface water from the site; no surface water samples were collected.
- There was an open adit present below the leach pad area that was classified as a potential hazard.
- A highwall was associated with the large partially backfilled trench on the north side of the site.



**Viking PA# 39-077**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/18/93**

**SOLID MATRIX ANALYSES**

**Metals in soils**  
**Results per dry weight basis**

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 39-077-WR-1 | 719 J         | 51.9 J        | 2.4 J         | 17.3 J        | 8.9 J         | 128 JX        | 32500 J       | 0.038 U       | 562 J         | 9 J           | 796 J         | 5 U           | 604 JX        | 0.32 U             |
| 39-077-WR-2 | 168 J         | 44.6 J        | 0.4 U         | 8.6 J         | 9.9 J         | 56.6 JX       | 18800 J       | 0.026 U       | 467 J         | 9 J           | 586 J         | 4 U           | 194 JX        | 0.564              |
| BACKGROUND  | 163           | 147           | 0.6 U         | 9.2           | 9.3           | 21.7          | 35800         | 0.066 JX      | 933 J         | 9             | 30            | 8 J           | 78 J          | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**Acid/Base Accounting**

| FIELD ID    | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|----------------------|---|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 39-077-WR-1 | 0.04                 | 1.25                                    | 5.61                          | 4.36                                      | 0.04                   | <0.01                  | 0.01                   | 0   | 5.61                                      |
| 39-077-WR-2 | 0.02                 | 0.62                                    | 6.03                          | 5.4                                       | 0.01                   | <0.01                  | 0.01                   | 0   | 6.03                                      |

**LEGEND**

WR1 - Sample of the WR1 subsample.  
 WR2 - Sample of the WR2 subsample.  
 BACKGROUND - From the Charter Oak Mine (39-003-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Emery</u>                          | County: <u>Powell</u>                     |
| Legal Description: <u>T 7N R 8W</u>                   | Section(s): <u>Sec. 10 and Sec. 11</u>    |
| Mining District: <u>Emery/Zosell</u>                  | Mine Type: <u>Hardrock/Au, Ag, Pb, Zn</u> |
| Latitude: <u>N 46° 22' 30"</u>                        | Primary Drainage: <u>Cottonwood</u>       |
| Longitude: <u>W 112° 35' 00"</u>                      | USGS Code: <u>17010201</u>                |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Rocker Gulch</u>   |
| Quad: <u>Baggs Creek/Sugarloaf Mountain</u>           | Date Investigated: <u>July 6, 1993</u>    |
| Inspectors: <u>Tuesday, Belanger, Lasher</u>          | P.A. # <u>39-004</u>                      |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- The volume of tailings associated with this site was estimated to be approximately 21,400 cubic yards. The following elements were elevated at least three times background:

|                      |                     |
|----------------------|---------------------|
| Arsenic: 6480J mg/kg | Cadmium: 17.1 mg/kg |
| Copper: 226J mg/kg   | Lead: 1560 mg/kg    |
| Antimony: 65J mg/kg  | Zinc: 2070 JX mg/kg |
  
- The volume of waste rock associated with this site was estimated to be approximately 244,625 cubic yards (over 12 waste rock dumps were observed). The following elements were elevated at least three times background:

|                                 |                              |
|---------------------------------|------------------------------|
| Arsenic: 3630J to 12,900J mg/kg | Cadmium: 34 to 87.2 mg/kg    |
| Copper: 3131J to 472J mg/kg     | Mercury: 0.785 to 1.56 mg/kg |
| Manganese: 8080J mg/kg          | Nickel: 29J to 81J mg/kg     |
| Lead: 1970 to 9230 mg/kg        | Antimony: 32J to 564J mg/kg  |
| Zinc: 2070JX to 9910JX mg/kg    |                              |
  
- This site was situated on both sides and between two flowing streams: Rocker Gulch and North Fork Rocker Gulch. North Fork Rocker Gulch intersected the site from the north and disappeared into the ground before reaching the tailings ponds located in the center of the site. Rocker Gulch intersected the site from the northeast and disappeared into the ground on the north side of the tailings ponds. Rocker Gulch reappeared farther south on the south side of WR-9. No MCLs were exceeded in upstream samples collected from either stream; however, acute aquatic life criteria for cadmium and chronic aquatic life criteria were exceeded for cadmium and lead in North Fork Rocker Gulch. Chronic aquatic life criteria were exceeded for cadmium and mercury in Rocker Gulch. The MCL for arsenic and chronic aquatic life criteria were exceeded for cadmium and mercury in the downstream Rocker Gulch sample.
  
- Observed releases to Rocker Gulch were documented for arsenic, mercury, lead, and zinc.
  
- Three potentially hazardous mine openings including two shafts and one adit were observed during the investigation.

**Emery PA# 39-004**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 07/16/93**

**SOLID MATRIX ANALYSES**

| Metals in soils   |                | Results per dry weight basis   |                         |                                  |            |            |            |                                  |                                  |            |            |            |            |                 |
|---|----------------|--------------------------------|-------------------------|----------------------------------|------------|------------|------------|----------------------------------|----------------------------------|------------|------------|------------|------------|-----------------|
| FIELD ID  | As (mg/Kg)     | Ba (mg/Kg)                     | Cd (mg/Kg)              | Co (mg/Kg)                       | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg)                       | Mn (mg/Kg)                       | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 39-004-SE-1   | 318            | 49.5                           | 5.7                     | 15.8                             | 39.5       | 28.6       | 38500      | 0.151                            | 970                              | 18         | 645        | 6 UJ       | 957        | NR              |
| 39-004-SE-2   | 157            | 110                            | 2.9                     | 17.1                             | 32.1       | 26.1       | 45400      | 0.15                             | 1210                             | 8          | 141        | 8 UJ       | 247        | NR              |
| 39-004-SE-3   | 454            | 77.2                           | 5.5                     | 20.2                             | 43.7       | 29.5       | 47700      | 0.182                            | 1010                             | 14         | 303        | 7 UJ       | 1020       | NR              |
| 39-004-SE-4   | 390 J          | 159 J                          | 7                       | 42.7 JX                          | 60.3 JX    | 64.4 J     | 89900 J    | 0.457                            | 2540 J                           | 46 J       | 462        | 19 UJ      | 620 JX     | NR              |
| 39-004-TP-1   | 6480 J         | 39.1 J                         | 17.1                    | 12.5 JX                          | 29.3 JX    | 226 J      | 43000 J    | 0.363                            | 3030 J                           | 19 J       | 1560       | 65 J       | 2070 JX    | NR              |
| 39-004-WR-1   | 12900 J        | 162 J                          | 87.2                    | 23.8 JX                          | 14.5 JX    | 472 J      | 81600 J    | 1.56                             | 8080 J                           | 29 J       | 9230       | 564 J      | 9910 JX    | NR              |
| 39-004-WR-2   | 6080 J         | 14.5 J                         | 34                      | 20.1 JX                          | 33.5 JX    | 175 J      | 61300 J    | 1.14                             | 3780 J                           | 81 J       | 5980       | 32 J       | 2070 JX    | NR              |
| 39-004-WR-3   | 3630 J         | 477 J                          | 56.3                    | 21.2 JX                          | 27.6 JX    | 313 J      | 45300 J    | 0.785                            | 11600 J                          | 13 J       | 1970       | 126 J      | 4490 JX    | NR              |
| BACKGROUND  | 91             | 295                            | 3.5                     | 13.9                             | 36.9       | 67.3       | 43400      | 0.165                            | 2960                             | 7          | 43         | 7 UJ       | 171        | NR              |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                |                                |                         |                                  |            |            |            |                                  |                                  |            |            |            |            |                 |
| Acid/Base Accounting  |                |                                |                         |                                  |            |            |            |                                  |                                  |            |            |            |            |                 |
| FIELD ID  | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE %  | PYRITIC %  | ORGANIC %  | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |            |            |            |            |                 |
| 39-004-TP-1   | 1.44           | 45                             | 90.6                    | 45.6                             | <0.01      | 1.24       | 0.27       | 38.7                             | 51.9                             |            |            |            |            |                 |
| 39-004-WR-1   | 4.5            | 141                            | 51                      | -90                              | 0.86       | 2.1        | 1.54       | 65.6                             | -14.6                            |            |            |            |            |                 |
| 39-004-WR-2   | 2.34           | 73.1                           | 94.3                    | 21.2                             | 0.77       | 0.98       | 0.59       | 30.6                             | 63.7                             |            |            |            |            |                 |
| 39-004-WR-3   | 3.04           | 95                             | 124                     | 28.6                             | 0.7        | 1.44       | 0.9        | 45                               | 78.6                             |            |            |            |            |                 |

**WATER MATRIX ANALYSES**

| Metals in Water   |                        |                 |         |           |         |        |      |         |        |        |      |        |                       | Results in ug/L |  |
|---|------------------------|-----------------|---------|-----------|---------|--------|------|---------|--------|--------|------|--------|-----------------------|-----------------|--|
| FIELD ID  | As                     | Ba              | Cd      | Co        | Cr      | Cu     | Fe   | Hg      | Mn     | Ni     | Pb   | Sb     | CALC. Zn (mg CaCO3/L) |                 |  |
| 39-004-SW-1   | 15.5                   | 7.43            | 3.63 J  | 9.7 U     | 6.83 U  | 1.6    | 152  | 0.038 U | 13.1   | 12.7 U | 10.7 | 30.7 U | 54.5                  | 70.6            |  |
| 39-004-SW-2   | 12.6                   | 8.73            | 3.13 J  | 9.7 U     | 6.83 U  | 1.55 U | 411  | 0.038 U | 29     | 12.7 U | 2.88 | 30.7 U | 7.57 U                | 42.7            |  |
| 39-004-SW-3   | 92.4                   | 11.2            | 3.9 J   | 9.7 U     | 6.83 U  | 1.55 U | 152  | 0.250   | 11.9   | 12.7 U | 6.76 | 30.7 U | 32.3                  | 214             |  |
| 39-004-SW-4   | 8.61                   | 10              | 2.6 J   | 9.7 U     | 6.83 U  | 1.55 U | 21.7 | 0.052   | 4.08 U | 12.7 U | 1.61 | 30.7 U | 7.57 U                | 111             |  |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                        |                 |         |           |         |        |      |         |        |        |      |        |                       |                 |  |
| Wet Chemistry   |                        | Results in mg/l |         |           |         |        |      |         |        |        |      |        |                       |                 |  |
| FIELD ID  | TOTAL DISSOLVED SOLIDS | CHLORIDE        | SULFATE | NO3/NO2-N | CYANIDE |        |      |         |        |        |      |        |                       |                 |  |
| 39-004-SW-1   | 123                    | < 5.0           | 21      | < 0.05    | NR      |        |      |         |        |        |      |        |                       |                 |  |
| 39-004-SW-2   | 83                     | < 5.0           | 12      | < 0.05    | NR      |        |      |         |        |        |      |        |                       |                 |  |
| 39-004-SW-3   | 305                    | < 5.0           | 114     | < 0.05    | NR      |        |      |         |        |        |      |        |                       |                 |  |
| 39-004-SW-4   | 179                    | < 5.0           | 46      | < 0.05    | NR      |        |      |         |        |        |      |        |                       |                 |  |

SE1 - Downstream N. Fork Rocker Gulch.

SE2 - Upstream N. Fork Rocker Gulch.

SE3 - Downstream Rocker Gulch.

SE4 - Upstream Rocker Gulch.

TP1 - Composite of subsamples TP1a, 1B, 2, 3, and 4.

WR1 - Composite of subsamples WR1A, 1B, 2, and 3.

WR2 - Composite of subsamples WR4A, 4B, 5, 6, 7, and 8.

WR3 - Composite of subsamples WR9A, 9B, 9C, 10A, 10B, 12A, and 12B.

LEGEND

BACKGROUND - From the Emery Mine (39-004-SS-1).

SW1 - Same as sample SE1.

SW2 - Same as sample SE2.

SW3 - Same as sample SE3.

SW4 - Same as sample SE4.

**LEGEND**

SE1 - Downstream N. Fork Rocker Gulch.  
 SE2 - Upstream N. Fork Rocker Gulch.  
 SE3 - Downstream Rocker Gulch.  
 SE4 - Upstream Rocker Gulch.  
 TP1 - Composite of subsamples TP1a, 1B, 2, 3, and 4.  
 WR1 - Composite of subsamples WR1A, 1B, 2, and 3.  
 WR2 - Composite of subsamples WR4A, 4B, 5, 6, 7, and 8.  
 WR3 - Composite of subsamples WR9A, 9B, 9C, 10A, 10B, 12A, and 12B.  
 BACKGROUND - From the Emery Mine (39-004-SS-1).  
 SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.  
 SW3 - Same as sample SE3.  
 SW4 - Same as sample SE4.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>NE NW S32</u>                      | County: <u>Powell</u>                      |
| Legal Description: T <u>11N</u> R <u>7W</u>           | Section(s): <u>NE 1/4, NW 1/4, Sec. 32</u> |
| Mining District: <u>Ophir</u>                         | Mine Type: <u>Hardrock/Placer, Au</u>      |
| Latitude: <u>N 46° 40' 15"</u>                        | Primary Drainage: <u>Carpenter Creek</u>   |
| Longitude: <u>W 112° 30' 30"</u>                      | USGS Code: <u>17010201</u>                 |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Carpenter Creek</u> |
| Quad: <u>Avon</u>                                     | Date Investigated: <u>July 15, 1993</u>    |
| Inspectors: <u>Bullock, Flammang, Clark</u>           | P.A. # <u>39-052</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no mill tailings associated with this site.
- The volume of waste rock at this site was estimated to be 90 cubic yards with additional disturbance south of the site associated with recent trenching. Iron at 48,154 mg/kg was elevated at least three times background.
- Some of the waste rock had been used to construct small settling basins for discharge from Adit #1. There was no discharge occurring from that adit during this investigation.
- Water flowing from Adit #2 appeared to be Carpenter Creek water, the pH of the possible discharge was 7.94 and had a specific conductance of 309 umhos/cm. Field measurements were similar to Carpenter Creek up and downstream of the adit.
- Carpenter Creek bisected the site. A downstream sediment sample contained no elements that were elevated three times above background.
- Both Adit #1 and #2 were open and hazardous.



NE NW Section 32 PA# 39-062  
AMRB HAZARDOUS MATERIALS INVENTORY  
INVESTIGATOR: PIONEER - BULLOCK  
INVESTIGATION DATE: 07/16/93

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD<br>ID | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 39-052-SE-1 | 5 U           | 78.4          | 0.8 J         | 10.1          | 12.7          | 38 JX         | 15200         | 0.063 J       | 405           | 11 JX         | 22 J          | 7 UJ          | 43 J          | NR                 |
| BACKGROUND  | 71            | 312           | 5.6           | 13            | 18            | 224           | 15800         | 0.296         | 1570          | 15            | 156           | 9 UJ          | 240           | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

**LEGEND**

SE1 - Downstream of site.

BACKGROUND - From the Victory/Evening Star (25-010-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Curlew  
Legal Description: T Mn R W  
Mining District: Curlew  
Latitude: N 46° 27' 49"  
Longitude: W 114° 10' 45"  
Land Status: Private  
Quad: Victor  
Inspectors: Bullock, Tuesday  
Organization: Pioneer Technical Services, Inc.

County: Ravalli  
Section(s): NE 1/4, NE 1/4, Sec. 14  
Mine Type: Hardrock/Au, Ag, Pb, Cu, Zn  
Primary Drainage: Battered River  
USGS Code: 17010205  
Secondary Drainage: Big Creek  
Date Investigated: September 9, 1993  
P.A. # 41-003

- An estimated 41,000 cubic yards of tailings were present on the site. The tailings were about 60% unvegetated at the time of this investigation. The following elements were elevated at least three times background:

|                                |                           |
|--------------------------------|---------------------------|
| Arsenic: 1640-3160 mg/kg       | Cadmium: 39.6-47.5 mg/kg  |
| Copper: 286-749 mg/kg          | Iron: 74,900-76,100 mg/kg |
| Manganese: 29,600-32,000 mg/kg | Nickel: 31.8-33.3 mg/kg   |
| Lead: 3140-4450 mg/kg          | Antimony: 27J-33.1J mg/kg |
| Zinc: 18,300-20,300 mg/kg      |                           |
- The volume of waste rock associated with this site was estimated to be 82,110 cubic yards. The following elements were elevated at least three times background:

|                         |                       |
|-------------------------|-----------------------|
| Arsenic: 48.3-692 mg/kg | Mercury: 0.439J mg/kg |
| Lead: 509 mg/kg         | Manganese: 8790 mg/kg |
| Zinc: 1930 mg/kg        |                       |
- The waste rock was mostly unvegetated.
- No discharging adits, seeps or springs were observed on site.
- A large pond was present in the glory hole, with a moderately high pH of 8.71. No exceedances of MCL/MCLGs or aquatic life criteria were documented, with the exception of the chronic aquatic life criteria for mercury.
- Two irrigation ditches that were flowing, at the time of this investigation, bisected the site. No samples were collected due to lack of runoff from the site. Spring runoff sampling was recommended for this site.
- The north end of TP-1 had recently been used for a household garbage disposal area.
- Two open adits, two structures, and the highwall associated with the glory hole were classified as potential hazards.

**Curlew PA# 41-003**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 09/09/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 41-003-TP-1 | 3160       | 6.12       | 47.5       | 2.21       | 5.77       | 749        | 76100      | 0.163 J    | 29600      | 31.8       | 4450       | 33.1 J     | 20300      | NR              |
| 41-003-TP-2 | 1640       | 10.5       | 39.6       | 2.89       | 5.66       | 286        | 74900      | 0.069 J    | 32000      | 33.3       | 3140       | 27 J       | 18300      | NR              |
| 41-003-WR-1 | 692        | 53.4       | 1.3        | 4.65       | 4.91       | 11.8       | 27600      | 0.091 J    | 8790       | 16         | 509        | 4.74 UJ    | 1930       | NR              |
| 41-003-WR-2 | 48.3       | 1000       | 0.9 U      | 2.39       | 3.52       | 13         | 31200      | 0.439 J    | 508        | 8.33       | 32.7       | 5.94 UJ    | 86.8       | NR              |
| BACKGROUND  | 5.04 U     | 357 J      | 0.6 U      | 8.34 J     | 8.69       | 5.95 J     | 10700      | 0.144      | 2320 J     | 7.66       | 18.4       | 6.56 UJ    | 58.9       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 41-003-TP-1 | 1.07           | 33.4                           | 81                       | 47.6                             | <0.01            | 0.59             | 0.53             | 18.4                             | 62.6                             |
| 41-003-TP-2 | 0.61           | 19.1                           | 121                      | 102                              | <0.01            | 0.25             | 0.4              | 7.81                             | 113                              |
| 41-003-WR-1 | 0.27           | 8.43                           | 145                      | 136                              | 0.03             | 0.1              | 0.14             | 3.12                             | 141                              |
| 41-003-WR-2 | 0.59           | 18.4                           | 259                      | 240                              | 0.04             | 0.05             | 0.5              | 1.56                             | 257                              |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As      | Ba   | Cd     | Co    | Cr     | Cu     | Fe   | Hg   | Mn   | Ni | Pb   | Sb       | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|---------|------|--------|-------|--------|--------|------|------|------|----|------|----------|-----------------|----------------|
| 41-003-SW-1 | 7.18 JX | 17.8 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 27.9 | 0.13 | 35.8 | 16 | 3.82 | 30.7 UJX | 47.5            | 528            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 41-003-SW-1 | 835                    | < 5.0    | 560     | < 0.05    | NR      |

**LEGEND**

TP1 - Composite of subsamples TP1A, 1B, 1C-A, 1C-B, and 1C-C.

SW1 - Pond in bottom of Glory Hole.

TP2 - Composite of subsamples TP2A, 2B-A, and 2B-C.

WR1 - Composite of subsamples WR1A\_B, 2, 3A, and 3B.

WR2 - Composite of subsamples WR4A, 4B, 5A, 5B, 6A, and 6B.

BACKGROUND - From the Mill Creek Mine (32-049-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Montana Prince</u>                 | County: <u>Ravalli</u>                        |
| Legal Description: <u>T 3N R 17W</u>                  | Section(s): <u>NE 1/4, NW 1/4, Sec. 14</u>    |
| Mining District: <u>Frog Pond Basin</u>               | Mine Type: <u>Hardrock/Au, Ag, Cu, Pb, Zn</u> |
| Latitude: <u>N 46° 00' 51"</u>                        | Primary Drainage: <u>Moose Creek</u>          |
| Longitude: <u>W 113° 40' 55"</u>                      | USGS Code: <u>17010205</u>                    |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Cuba Creek</u>         |
| Quad: <u>Whetstone Ridge</u>                          | Date Investigated: <u>June 22, 1993</u>       |
| Inspectors: <u>Flammang, Clark</u>                    | P.A. # <u>41-004</u>                          |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There are no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be approximately 3000 cubic yards. The following elements were elevated at least three times background:

|                        |                       |
|------------------------|-----------------------|
| Cadmium: 5.7 mg/kg     | Copper: 41.6 mg/kg    |
| Mercury: 0.829JX mg/kg | Manganese: 1220 mg/kg |
| Lead: 267 mg/kg        | Zinc: 292 mg/kg       |
- There was one adit discharge associated with this site. The discharge flow rate was approximately 1 gpm, the pH was 7.54, and the specific conductance was 120 umhos/cm. The discharge did not exceed any of the applicable MCL/MCLGs or aquatic life criteria. The discharge seeped into the dump near the adit and then reappeared below the waste rock dump.
- This seep constituted the headwater of a small tributary to Cuba Creek. The manganese concentration measured in the seep was elevated greater than three times the adit discharge concentration, constituting the only observed release. The seep did not exceed any of the applicable MCL/MCLGs or aquatic life criteria.



**Montana Prince PA# 41-004**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/22/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 41-004-SE-1 | 6 J        | 65.1       | 5.7        | 4.4        | 2.3        | 16.7       | 4380       | 0.726 JX   | 829        | 6          | 19         | 3 UJ       | 278        | NR              |
| 41-004-WR-1 | 7 J        | 146        | 5.7        | 9.3        | 5.5        | 41.6       | 20900      | 0.829 JX   | 1220       | 12         | 267        | 4 UJ       | 292        | NR              |
| BACKGROUND  | 11 J       | 267        | 1.7        | 11         | 8.7        | 7.8        | 12800      | 0.08 JX    | 250        | 9          | 15         | 5 UJ       | 62         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 41-004-WR-1 | 1.24           | 38.7                           | 46.7                    | 7.92                             | 0.27             | 0.41             | 0.56             | 12.8                             | 33.8                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu   | Fe   | Hg      | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|--------|-------|--------|------|------|---------|------|--------|--------|--------|-----------------|----------------|
| 41-004-GW-1 | 0.98 U | 22.3 | 2.57 U | 9.7 U | 6.83 U | 1.97 | 25.5 | 0.038 U | 4.5  | 12.7 U | 0.38 U | 30.7 U | 7.57 U          | 44.4           |
| 41-004-SW-1 | 0.98 U | 18   | 2.57 U | 9.7 U | 6.83 U | 2.03 | 43.3 | 0.038 U | 23.3 | 12.7 U | 0.38 U | 30.7 U | 13.2            | 44.8           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 41-004-GW-1 | 88                     | < 5.0    | 5       | < 0.05    | NR      |
| 41-004-SW-1 | 82                     | < 5.0    | 6       | < 0.05    | NR      |

**LEGEND**

SE1 - 10 feet below toe of waste rock dump 1.  
WR1 - Composite of subsamples WR1A and 1B.  
BACKGROUND - From the Montana Prince (41-004-SS-1).

GW1 - Water seeping from collapsed adit.  
SW1 - Same as sample SE1.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Lucky Joe</u>                      | County: <u>Ravalli</u>                              |
| Legal Description: <u>T 3S R 22W</u>                  | Section(s): <u>NW 1/4, NE 1/4, Sec. 9</u>           |
| Mining District: <u>Hughes Creek</u>                  | Mine Type: <u>Hardrock/Uranium</u>                  |
| Latitude: <u>N 45° 35' 33"</u>                        | Primary Drainage: <u>West Fork Bitterroot River</u> |
| Longitude: <u>W 114° 19' 00"</u>                      | USGS Code: <u>17010205</u>                          |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>None</u>                     |
| Quad: <u>Alta</u>                                     | Date Investigated: <u>June 22, 1993</u>             |
| Inspectors: <u>Bullock, Flammang, Clark</u>           | P.A. # <u>41-027</u>                                |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be 360 cubic yards. The following elements were elevated at least three times background:  
Chromium: 60.2 mg/kg                      Nickel: 30J mg/kg.
- The waste rock dumps were mostly unvegetated. The mine was reported to have been an uranium mine, but no unusual radiation levels were measured.
- No discharging adits, seeps, or springs were observed.
- The nearest surface water was greater than 600 feet away with no direct runoff pathways. Therefore, no surface water or stream sediment samples were collected.
- Classified hazards included two open adits; Adit #1 was easily accessible, Adit #2 had a narrow opening but still could be entered. In addition, a 75 foot highwall was present above Adit #1.

**Lucky Joe PA# 41-027**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 06/22/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 41-027-WR-1 | 4 U           | 30.8          | 0.6           | 7.9           | 60.2          | 5.2 J         | 12600         | 0.02          | 135           | 30 J          | 5 J           | 4 U           | 13            | NR                 |
| BACKGROUND  | 5.04 U        | 357 J         | 0.6 U         | 8.34 J        | 8.69          | 5.95 J        | 10700         | 0.144         | 2320 J        | 7.66          | 18.4          | 6.56 UJ       | 58.9          | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|----------------------|---|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 41-027-WR-1 | <0.01                | 0                                       | 24.7                          | 24.7                                      | <0.01                  | <0.01                  | <0.01                  | 0   | 24.7                                      |

**LEGEND**

WR1 - Composite of subsamples WR1A, 1B, 1C, and 2A.  
BACKGROUND - From the Mill Creek (32-049-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Bluebird</u>                       | County: <u>Ravalli</u>                      |
| Legal Description: T <u>7N</u> R <u>21W</u>           | Section(s): <u>NE 1/4, SW 1/4, Sec. 4</u>   |
| Mining District: <u>Pleasant View</u>                 | Mine Type: <u>Hardrock/Ag. Cu</u>           |
| Latitude: <u>N 46° 23' 24"</u>                        | Primary Drainage: <u>Bitterroot River</u>   |
| Longitude: <u>W 114° 13' 53"</u>                      | USGS Code: <u>17010205</u>                  |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Bear Creek</u>       |
| Quad: <u>Victor</u>                                   | Date Investigated: <u>September 8, 1993</u> |
| Inspectors: <u>Bullock, Tuesday</u>                   | P.A. # <u>41-009</u>                        |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be 2140 cubic yards. The following elements were elevated at least three times background:  
Copper: 117 mg/kg                      Mercury: 1.43J mg/kg  
Lead: 64.9 mg/kg
- The waste rock was mostly unvegetated.
- One adit at the site appeared to have had an occasional discharge. It was not, however, discharging at the time of the investigation. A small seep or precipitation puddle was present at the north end of WR-4.
- A intermittent tributary to Bear Creek was present along the south side of the site. This tributary was dry at the time of this investigation. Stream sediment samples collected in this drainage documented an observed release for mercury.
- Shafts were open and classified as hazardous at WR-2 and WR-4. The shaft at WR-2 had been used for illegal household garbage disposal. The highwall in the borrow pit area was approximately 40 feet high.



Blue Bird PA# 41-009  
AMRB HAZARDOUS MATERIALS INVENTORY  
INVESTIGATOR: PIONEER - BULLOCK  
INVESTIGATION DATE: 09/08/93

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 41-009-SE-1 | 14.7 J        | 138           | 0.6 U         | 9.31          | 7.29          | 35            | 24300         | 0.41 J        | 1550          | 5.03          | 48.5          | 6.61 UJ       | 157 J         | NR                 |
| 41-009-SE-2 | 12.8 J        | 160           | 0.6 U         | 6.1           | 3.76          | 20.6          | 14100         | 0.034 U       | 1700          | 3.6           | 21.8          | 7.24 UJ       | 203 J         | NR                 |
| 41-009-WR-1 | 7.28 J        | 24.2          | 0.6           | 1.94 U        | 1.37 U        | 117           | 6890          | 1.43 J        | 237           | 2.53 U        | 64.9          | 6.13 UJ       | 102 J         | NR                 |
| BACKGROUND  | 5.04 U        | 357 J         | 0.6 U         | 8.34 J        | 8.69          | 5.95 J        | 10700         | 0.144         | 2320 J        | 7.66          | 18.4          | 6.56 UJ       | 58.9          | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL.<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|----------------------|---|--------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 41-009-WR-1 | 0.21                 | 6.56                                    | 12.6                           | 6.05                                      | 0.1                    | 0.02                   | 0.09                   | 0.62                                      | 12  |

**LEGEND**

SE1 - Downgradient sediment sample in intermittent drainage.  
SE2 - Upgradient sediment sample in intermittent drainage.  
WR1 - Composite of subsamples WR2, 3, and 4.  
BACKGROUND - From the Mill Creek Mine (32-049-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Broken Hill</u>                    | County: <u>Sanders</u>                              |
| Legal Description: T <u>27N</u> R <u>34W</u>          | Section(s): <u>SW 1/4, SW, 1/4, NE 1/4, Sec. 10</u> |
| Mining District: <u>Blue Creek</u>                    | Mine Type: <u>Hardrock/Ag, Pb, Zn</u>               |
| Latitude: <u>N 48° 07' 15"</u>                        | Primary Drainage: <u>East Fork Blue Creek</u>       |
| Longitude: <u>W 115° 58' 06"</u>                      | USGS Code: <u>17010213</u>                          |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>East Fork Blue Creek</u>     |
| Quad: <u>Heron</u>                                    | Date Investigated: <u>August 3, 1993</u>            |
| Inspectors: <u>Bullock, Flammang, Clark</u>           | P.A. # <u>45-005</u>                                |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be 6200 cubic yards. The following elements were elevated at least three times background:

|                            |                                |
|----------------------------|--------------------------------|
| Arsenic: 508 to 1140 mg/kg | Mercury: 2.53J to 27.2J mg/kg. |
| Cadmium: 15.2 to 26 mg/kg  | Lead: 18,700J to 55,900J mg/kg |
| Copper: 140J to 342J mg/kg | Antimony: 61.3 to 344 mg/kg    |
| Iron: 94,400 mg/kg         | Zinc: 9600 to 11,400 mg/kg.    |
- The waste rock dumps were mostly unvegetated.
- A collapsed discharging adit (GW-1) was present, with a flow of approximately 25 gpm, a pH of 8.71, and a specific conductance of 75 umhos/cm. The adit discharge did not exceed any MCL/MCLGs. Chronic aquatic life criteria for mercury, lead and zinc and acute aquatic life criteria for lead and zinc were exceeded in this sample of the discharge.
- A dry tributary to the East Fork of Dry Creek was approximately 100 feet north of the site. There were no direct runoff pathways to surface water identified during this investigation. Therefore, surface water and stream sediment samples were not collected.
- One plastic barrel half full of an unknown material was present at the base of WR-1.

**Broken Hill PA# 45-005**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER -BULLOCK**  
**INVESTIGATION DATE: 08/03/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 45-005-WR-1 | 1140       | 27.9       | 15.2       | 7.25       | 5.25       | 342 J      | 94400      | 27.2 J     | 992        | 3.84       | 55900 J    | 344        | 9600       | NR              |
| 45-005-WR-2 | 508        | 19.8       | 26         | 5.86       | 4.5        | 140 J      | 44200      | 2.53 J     | 426        | 6.23       | 18700 J    | 61.3       | 11400      | NR              |
| BACKGROUND  | 8.68       | 142        | 0.6 U      | 10.4       | 10.5       | 21.2 J     | 22100      | 0.06 J     | 710        | 14.4       | 33.8 J     | 6.84 U     | 78.2       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 45-005-WR-1 | 2.80           | 87.5                           | -5.78                    | -93.3                            | 1.86             | 0.08             | 0.86             | 2.50                             | -8.28                            |
| 45-005-WR-2 | 2.46           | 76.9                           | -4.12                    | -81.0                            | 0.59             | 0.15             | 1.72             | 4.69                             | -8.81                            |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba     | Cd     | Co    | Cr     | Cu   | Fe   | Hg      | Mn   | Ni     | Pb  | Sb     | Zn (mg CaCO <sub>3</sub> /L) | HARDNESS CALC. |
|-------------|------|--------|--------|-------|--------|------|------|---------|------|--------|-----|--------|------------------------------|----------------|
| 45-005-GW-1 | 30.4 | 2.01 U | 2.57 U | 9.7 U | 6.83 U | 2.97 | 69.6 | 0.044 J | 15.2 | 12.7 U | 107 | 30.7 U | 867                          | 23.4           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD I.D.  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO <sub>3</sub> /NO <sub>2</sub> -N | CYANIDE |
|-------------|------------------------|----------|---------|-------------------------------------|---------|
| 45-005-GW-1 | 52                     | 6.7      | < 5     | < 0.05                              | NR      |

**LEGEND**

WR1 - Composite of subsamples WR1A, 1B, 1C, and 3.

GW1 - From the flow out of adit #2.

WR2 - Composite of subsamples WR2A and 2B.

BACKGROUND - From the Holliday Mine (45-009-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Montro Gold</u>                    | County: <u>Sanders</u>                    |
| Legal Description: T <u>19N</u> R <u>26W</u>          | Section(s): <u>SW 1/4, NW 1/4, Sec. 3</u> |
| Mining District: <u>Plains</u>                        | Mine Type: <u>Hardrock/Unknown</u>        |
| Latitude: <u>N 47° 26' 08"</u>                        | Primary Drainage: <u>Clark Fork River</u> |
| Longitude: <u>W 114° 54' 00"</u>                      | USGS Code: <u>17010213</u>                |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Combest Creek</u>  |
| Quad: <u>Plains</u>                                   | Date Investigated: <u>August 6, 1993</u>  |
| Inspectors: <u>Bullock, Clark</u>                     | P.A. # <u>45-010</u>                      |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be 6300 cubic yards. The following elements were elevated at least three times background:

|                              |                            |
|------------------------------|----------------------------|
| Copper: 125J to 345J mg/kg   | Iron: 41,000 mg/kg         |
| Mercury: 0.306 to 1.51 mg/kg | Lead: 4280 to 27,500 mg/kg |
| Antimony: 28 mg/kg.          |                            |
- The waste rock dump was 90% unvegetated.
- A collapsed discharging adit (GW-1) was present, with a low flow of approximately 2-3 gpm, a pH of 8.36, and a specific conductance of 250 umhos/cm. The adit discharge did not exceed MCL/MCLGs, but chronic aquatic life criteria for mercury, cadmium, and lead were exceeded.
- Residents downgradient from this site were apparently on a community water supply.
- There were no surface water expressions associated with this site.
- One adit was open with a gate and was classified as a potentially hazardous mine opening.



**Montro Gold PA# 45-010**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/06/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 45-010-WR-1 | 6 J        | 43.7       | 1.3        | 22.7       | 7.2        | 125 J      | 34400      | 1.51       | 733 J      | 18         | 4280       | 5 UJ       | 57         | NR              |
| 45-010-WR-2 | 7 J        | 30         | 1.7        | 13.1       | 4.3        | 345 J      | 41000      | 0.306      | 492 J      | 9          | 27500      | 28         | 17         | NR              |
| BACKGROUND  | 4.44 U     | 234        | 1.06       | 8.15       | 7.26       | 8.33       | 12900      | 0.037      | 987        | 9.72       | 21.3       | 5.79 U     | 95.2       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID       | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|----------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 45-010-WR-1DUP | 0.05           | 1.56                           | 4.38                     | 2.82                             | 0.03             | <0.01            | 0.02             | 0.00                             | 4.38                             |
| 45-010-WR-1    | 0.06           | 1.87                           | 4.42                     | 2.54                             | 0.03             | 0.01             | 0.02             | 0.31                             | 4.11                             |
| 45-010-WR-2    | 0.21           | 6.56                           | 2.15                     | -4.41                            | 0.19             | 0.01             | 0.01             | 0.31                             | 1.84                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd   | Co    | Cr     | Cu   | Fe    | Hg       | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|------|-------|--------|------|-------|----------|------|--------|--------|--------|-----------------|----------------|
| 45-010-GW-1 | 2.92 J | 25.7 | 2.57 | 9.7 U | 6.83 U | 5.13 | 585 J | 0.230 JX | 53.2 | 12.7 U | 23.2 J | 30.7 U | 13.8 J          | 78             |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD I.D.  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 45-010-GW-1 | 141                    | 6.7      | 11      | 0.37      | NR      |

**LEGEND**

WR1 - Composite of subsamples WR1A, 1B, and 2A.

GW1 - Lower adit discharge.

WR2 - Sample of the WR2B subsample.

BACKGROUND - From the Montro Gold Mine (45-010-SS-1).

WR1DUP - Duplicate of the sample 45-010-WR-1.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Dee Creek Mine</u>                 | County: <u>Sanders</u>                     |
| Legal Description: T <u>20N</u> R <u>28W</u>          | Section(s): <u>SE 1/4, SE 1/4, Sec. 25</u> |
| Mining District: <u>Plains</u>                        | Mine Type: <u>Hardrock/Unknown</u>         |
| Latitude: <u>N 47° 27' 30"</u>                        | Primary Drainage: <u>Swamp Creek</u>       |
| Longitude: <u>W 115° 05' 40"</u>                      | USGS Code: <u>17010213</u>                 |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Dee Creek</u>       |
| Quad: <u>Sunset Peak</u>                              | Date Investigated: <u>August 6, 1993</u>   |
| Inspectors: <u>Flammang, Belanger</u>                 | P.A. # <u>45-041</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be 250 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 201J mg/kg  
Mercury: 0.955 mg/kg.
- The waste rock dump was approximately 60% unvegetated.
- A collapsed discharging adit (GW-1) was present, with a very small flow of 1 gpm, a pH of 6.33, and a specific conductance of 620 umhos/cm. The adit discharge did not exceed MCL/MCLGs, but chronic aquatic life criteria for mercury was exceeded.
- Dee Creek flowed past the south side of the site. Water in the creek did not exceed MCL/MCLGs. Water samples did exceed aquatic life standards (chronic) for mercury, lead, and zinc. The upstream sample exceeded aquatic life standards (chronic) for mercury, and lead indicating a possible upstream contaminant source. No release of any elements was documented from the site in either surface water or sediments.
- A hazardous inclined shaft (Adit #2) was present at the site.

**Dee Creek PA# 45-041**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/06/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 45-041-SE-1 | 69 J       | 68.2       | 0.7 U      | 7.7        | 9          | 36.1 J     | 25800      | 0.048      | 355 J      | 15         | 19         | 8 UJ       | 67         | NR              |
| 45-041-SE-2 | 32 J       | 62.8       | 0.6 U      | 8.1        | 9.8        | 16.1 J     | 28700      | 0.05       | 379 J      | 14         | 26         | 7 UJ       | 72         | NR              |
| 45-041-WR-1 | 201 J      | 25.1       | 1.2        | 7          | 8.3        | 43.2 J     | 56100      | 0.955      | 200 J      | 7          | 82         | 5 UJ       | 44         | NR              |
| BACKGROUND  | 44 J       | 362        | 0.5 U      | 17.7       | 16.5       | 29.1 J     | 38500      | 0.044      | 611 J      | 38         | 42         | 6 UJ       | 147        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested; ND - No Data

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 45-041-WR-1 | 0.25           | 7.81                           | 0.76                    | -7.05                            | 0.23             | <0.01            | 0.02             | 0.00                             | 0.76                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba     | Cd     | Co    | Cr     | Cu     | Fe     | Hg       | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|--------|--------|-------|--------|--------|--------|----------|--------|--------|--------|--------|-----------------|----------------|
| 45-041-GW-1 | 2.89 J | 2.01 U | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 20.1 J | 0.230 JX | 4.08 U | 12.7 U | 1.22 U | 30.7 U | 8.17 J          | 15.1           |
| 45-041-GW-2 | 0.96 U | 2.01 U | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 11.8 U | 0.190 JX | 4.08 U | 12.7 U | 1.22 U | 30.7 U | 7.57 U          | 0.1            |
| 45-041-SW-1 | 1.14 J | 4.67   | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 17.6 J | 0.200 JX | 4.08 U | 12.7 U | 1.78 J | 30.7 U | 16.5 J          | 9.8            |
| 45-041-SW-2 | 0.96 U | 4.93   | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 11.8 U | 0.230 JX | 4.08 U | 12.7 U | 1.77 J | 30.7 U | 12.3 J          | 9.8            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested; ND - No Data

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 45-041-GW-1 | 35                     | 7.7      | < 5.0   | < 0.05    | NR      |
| 45-041-GW-2 | 6                      | 8.7      | < 5.0   | < 0.05    | NR      |
| 45-041-SW-1 | 36                     | 11       | < 5.0   | < 0.05    | NR      |
| 45-041-SW-2 | ND                     | ND       | ND      | < 0.05    | NR      |

**LEGEND**

SE1 - Downgradient of site approx. 50'.  
 SE2 - Upgradient of site approx. 50'.  
 WR1 - Composite of subsamples WR1A and 1B.  
 BACKGROUND - From Dee Creek Mine (45-041-SS-1).

GW1 - From seep just below caved mouth of adit #1.  
 GW2 - QA/QC Blank.  
 SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Lower Letterman  
Legal Description: T 19N R 26W  
Mining District: Plains  
Latitude: N 47° 25' 43"  
Longitude: W 114° 53' 37"  
Land Status: Private/Public  
Quad: Plains  
Inspectors: Bullock, Clark  
Organization: Pioneer Technical Services, Inc.

County: Sanders  
Section(s): SW 1/4, SE 1/4, Sec. 3  
Mine Type: Hardrock/Ag. Ag. Pb  
Primary Drainage: Clark Fork River  
USGS Code: 17010213  
Secondary Drainage: Combest Creek  
Date Investigated: August 6, 1993  
P.A. # 45-047

- No mill tailings were associated with this site.
- The volume of waste material at the site was estimated to be 423 cubic yards. The following elements were elevated at least three times background:  
Mercury: 0.543 mg/kg  
Lead: 2600 mg/kg
- The waste rock dumps were approximately 75% unvegetated.
- No discharging adits, seeps, or springs were observed during this investigation.
- Water present in the southern slope had a fairly neutral pH of 6.40, and a low specific conductance of 90 umhos/cm. This water appeared to be ponded precipitation
- The nearest surface water expression was Combest Creek approximately 400 feet from the site, Combest Creek was dry at the time of this investigation.
- There were two hazardous stopes present at the Lower Letterman and a hazardous open adit was present. The open adit was approximately 1/4 mile north of the site.



**Lower Letterman PA# 45-047**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/06/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
 Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 45-047-WR-1 | 4 U           | 42.4          | 1.5           | 9.3           | 5.9           | 19.3 J        | 24800         | 0.543         | 2510 J        | 16            | 2600          | 5 UJ          | 47            | NR                 |
| BACKGROUND  | 4.44 U        | 234           | 1.06          | 8.15          | 7.26          | 8.33          | 12900         | 0.037         | 987           | 9.72          | 21.3          | 5.79 U        | 95.2          | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|----------------------|---|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 45-047-WR-1 | 0.01                 | 0.31                                    | 8.55                          | 8.24                                      | 0.01                   | <0.01                  | <0.01                  | 0.00                                      | 8.55                                      |

**LEGEND**

WR1 - Composite of subsamples WR1 and 2.  
 BACKGROUND - From the Montro Gold Mine (45-010-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Holliday</u>                       | County: <u>Sanders</u>                             |
| Legal Description: T <u>26N</u> R <u>34W</u>          | Section(s): <u>SE 1/4, NE 1/4, Sec. 36</u>         |
| Mining District: <u>Trout Creek</u>                   | Mine Type: <u>Hardrock/Unknown</u>                 |
| Latitude: <u>N 47° 58' 30"</u>                        | Primary Drainage: <u>Pilgrim Creek</u>             |
| Longitude: <u>W 115° 54' 40"</u>                      | USGS Code: <u>17010213</u>                         |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>West Fork Pilgrim Creek</u> |
| Quad: <u>Gem Peak</u>                                 | Date: <u>August 3, 1993</u>                        |
| Inspectors: <u>Tuesday, Belanger, Lasher</u>          | P.A. # <u>45-009</u>                               |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no mill tailings observed at the site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 10,490 cubic yards. The following elements were elevated at least three times background:  
Lead: 371J mg/kg
- Two adits had minor discharges during the investigation. No MCLs were exceeded for either of the discharges. The chronic aquatic life criteria for lead was exceeded in the Adit #4 discharge.
- West Fork Pilgrim Creek and an unnamed tributary to West Fork Pilgrim Creek converge and flowed within 5 feet of a WR-4. No MCLs were exceeded in upstream or downstream samples collected in West Fork Pilgrim Creek; however, chronic aquatic life criteria for lead were exceeded in both the upstream and downstream samples. Upstream and downstream sediment samples collected in West Fork Pilgrim Creek exhibited metals concentrations similar to background.

**Holliday PA# 45-009**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - TUESDAY**  
**INVESTIGATION DATE: 08/03/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 45-009-SE-1 | 7.52       | 45.6       | 0.6 U      | 7.84       | 9.96       | 35.9 J     | 21000      | 0.041 J    | 406        | 11.5       | 65 J       | 7.17 U     | 96.6       | NR              |
| 45-009-SE-2 | 11.3       | 38.7       | 0.4 U      | 6.53       | 10.5       | 18.5 J     | 20900      | 0.021 J    | 398        | 12.6       | 50.4 J     | 5.27 U     | 94.6       | NR              |
| 45-009-WR-1 | 12         | 77.4       | 0.5 U      | 9.55       | 5.86       | 45.1 J     | 21300      | 0.032 J    | 513        | 11.1       | 371 J      | 6.07 U     | 125        | NR              |
| BACKGROUND  | 8.68       | 142        | 0.6 U      | 10.4       | 10.5       | 21.2 J     | 22100      | 0.06 J     | 710        | 14.4       | 33.8 J     | 6.84 U     | 78.2       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 45-009-WR-1 | 0.06           | 1.87                           | 25.7                    | 23.9                             | 0.01             | 0.02             | 0.03             | 0.62                             | 25.1                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu     | Fe     | Hg       | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|--------|-------|--------|--------|--------|----------|--------|--------|--------|--------|-----------------|----------------|
| 45-009-GW-1 | 1.69 U | 59.2 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 11.8 U | 0.038 U  | 4.08 U | 12.7 U | 3.16   | 30.7 U | 69.7            | 146            |
| 45-009-GW-2 | 2.54   | 59.7 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 11.8 U | 0.076 J  | 4.08 U | 12.7   | 2.89   | 30.7 U | 32              | 42.4           |
| 45-009-SW-1 | 1.54 J | 2.5  | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 17.6 J | 0.140 JX | 4.08 U | 12.7 U | 2.15 J | 30.7 U | 10.2 J          | 12.3           |
| 45-009-SW-2 | 1.74 J | 3.07 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 11.8 U | 0.190 JX | 4.08 U | 12.7 U | 1.38 J | 30.7 U | 7.57 U          | 13.1           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 45-009-GW-1 | 150                    | < 5.0    | 9       | < 0.05    | NR      |
| 45-009-GW-2 | 41                     | < 5.0    | < 5.0   | < 0.05    | NR      |
| 45-009-SW-1 | < 5.0                  | < 5.0    | < 5.0   | < 0.05    | NR      |
| 45-009-SW-2 | 31                     | < 5.0    | < 5.0   | < 0.05    | NR      |

**LEGEND**

SE1 - Upgradient on unnamed drainage.  
SE2 - Downgradient of mine in W. Fork Pilgrim Creek.  
WR1 - Composite of subsamples WR1, 2, 3A, 3B, 4A, and 4B.  
BACKGROUND - From the Holliday Mine (45-009-SS-1).

GW1 - Discharge from adit #3 (caved).  
GW2 - Discharge from adit #4 (pipe).  
SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Jack Waite</u>                     | County: <u>Sanders</u>                        |
| Legal Description: T <u>22N</u> R <u>32W</u>          | Section(s): <u>NE 1/4, SW 1/4, Sec. 17</u>    |
| Mining District: <u>White Pine</u>                    | Mine Type: <u>Hardrock/Au, Ag, Cu, Pb, Zn</u> |
| Latitude: <u>N 47° 39' 50"</u>                        | Primary Drainage: <u>Beaver Creek</u>         |
| Longitude: <u>W 115° 43' 15"</u>                      | USGS Code: <u>17010213</u>                    |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Dixie Creek</u>        |
| Quad: <u>Cooper Gulch</u>                             | Date Investigated: <u>September 7, 1993</u>   |
| Inspectors: <u>Bullock, Tuesday</u>                   | P.A. # <u>45-002</u>                          |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be 3800 cubic yards. The following elements were elevated at least three times background:  
Cadmium: 513 mg/kg                      Copper: 97.2 mg/kg  
Lead: 4150 mg/kg                      Zinc: 7920J mg/kg.
- The waste rock dump was unvegetated and also over-steepened in the drainage.
- A discharging adit (GW-1) was present, with a small flow of 3 gpm, a pH of 7.40, and a specific conductance of 280 umhos/cm. The adit discharge did not exceed MCL/MCLGs; but the chronic aquatic life criteria for lead was exceeded.
- Dixie Creek bisected the site. Water samples collected up and down stream of this site documented an observed release of lead and zinc to surface water. The samples did not exceed MCL/MCLGs. The acute and chronic aquatic life criteria were exceeded for lead and zinc, both attributable to this site. An observed release of lead was also documented in the stream sediment samples.
- One adit was open and classified as potentially hazardous.



**Jack Waite PA# 45-002**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 09/07/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 45-002-SE-1 | 9.91 J     | 69.2       | 1          | 9.06       | 1.53 U     | 36.6       | 16600      | 0.034 U    | 274        | 18         | 866        | 6.89 UJ    | 178 J      | NR              |
| 45-002-SE-2 | 21 J       | 68.3       | 0.8 U      | 16.2       | 5.91       | 20.1       | 21200      | 0.044 U    | 965        | 16.9       | 68.7       | 9.9 UJ     | 102 J      | NR              |
| 45-002-WR-1 | 25.1 J     | 56.7       | 513        | 9.47       | 1.7        | 97.2       | 22300      | 0.029 U    | 374        | 11.4       | 4150       | 11.9 J     | 7920 J     | NR              |
| BACKGROUND  | 8.68       | 142        | 0.6 U      | 10.4       | 10.5       | 21.2 J     | 22100      | 0.06 J     | 710        | 14.4       | 33.8 J     | 6.84 U     | 78.2       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 45-002-WR-1 | 0.53           | 16.6                           | 21.2                     | 4.68                             | 0.01             | 0.34             | 0.18             | 10.6                             | 10.6                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu     | Fe   | Hg       | Mn     | Ni      | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|--------|------|--------|-------|--------|--------|------|----------|--------|---------|------|--------|-----------------|----------------|
| 45-002-GW-1 | 5.83   | 16.2 | 2.57 U | 9.7 U | 6.83 U | 4.07 J | 160  | 0.12 UJX | 25.2   | 12.7 UX | 11.5 | 30.7 U | 18.9 J          | 122            |
| 45-002-SW-1 | 2.38   | 11.1 | 2.63 J | 9.7 U | 7.67   | 7.5 J  | 81.3 | 0.12 UJX | 4.08 U | 12.7 UX | 76.9 | 30.7 U | 82.7 J          | 62.9           |
| 45-002-SW-2 | 1.69 U | 4.07 | 3.03 J | 9.7 U | 6.83 U | 5.17 J | 75.3 | 0.12 UJX | 4.08 U | 16.3 JX | 4.41 | 30.7 U | 12.4 J          | 22.3           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID.   | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 45-002-GW-1 | 225                    | < 5.0    | 42      | < 0.05    | NR      |
| 45-002-SW-1 | 162                    | < 5.0    | 25      | < 0.05    | NR      |
| 45-002-SW-2 | 90                     | < 5.0    | 8       | < 0.05    | NR      |

**LEGEND**

SE1 - 200 feet downstream of waste rock dump 1.  
 SE2 - 100 feet upstream from waste rock dump 1.  
 WR1 - Composite of subsamples WR1A, 1B, and 1C.  
 BACKGROUND - From the Holliday Mine (45-009-SS-1).

GW1 - Adit discharge.  
 SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Highland  
Legal Description: T Mn R W  
Mining District: Basin Creek  
Latitude: N 45° 47' 50"  
Longitude: W 112° 31' 10"  
Land Status: Private/Public  
Quad: Mount Humbug  
Inspectors: Bullock/Pierson  
Organization: Pioneer Technical Services,  
Inc./ Thomas, Dean and Hoskins, Inc.

County: Silver Bow  
Section(s): NW 1/4, NE 1/4, Sec. 31  
Mine Type: Hardrock/Au  
Primary Drainage: Silver Bow Creek  
USGS Code: 17010201  
Secondary Drainage: Basin Creek  
Date Investigated: September 17, 1993  
P.A. # 47-028

- There were no mill tailings associated with this site. Ore from this mine was processed at the Middle Fork Millsite (PA# 47-081).
- The volume of waste rock associated with this site was estimated to be 40,000 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 139J mg/kg                      Mercury : 0.261J mg/kg  
Copper: 943 mg/kg                      Iron: 128,000JX mg/kg
- The waste rock dumps were approximately 90% unvegetated.
- One discharging adit had a flow of approximately 15 gpm, a pH of 7.42, and a specific conductance of 208 umhos/cm. No MCL/MCLG's were exceeded nor were any aquatic life criteria exceeded in the sample of this discharge.
- The discharge was a source for a perennial flow to Basin Creek. No MCL/MCLGs were exceeded in the downstream sample, however, the chronic aquatic life criteria for mercury was exceeded downstream from the site. The downstream sediment sample also exhibited copper concentrations greater than three times the background soil. Basin Creek was a source of drinking water for the City of Butte.
- Ten cubic yards of a white unknown powder was present at the south end of the site.

**Highland PA# 47-028**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 09/17/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 47-028-SE-1 | 26.5 J     | 32.3 J     | 1.1 U      | 4.05       | 3.61 J     | 38.9       | 9700 JX    | 0.038 J    | 289        | 71.9       | 42.9       | 7.68 UJ    | 305 J      | NR              |
| 47-028-WR-1 | 139 J      | 38.7 J     | 1.9 J      | 9.77       | 1.81 J     | 943        | 128000 JX  | 0.261 J    | 491        | 7.57       | 13.5       | 7.09 UJ    | 79.4 J     | NR              |
| BACKGROUND  | 40.1 J     | 173 J      | 1.1 U      | 10.1       | 21.1 J     | 34.3       | 18500 JX   | 0.039 J    | 832        | 18.1       | 14.8       | 7.28 UJ    | 61.9 J     | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 47-028-WR-1 | 1.64           | 51.2                           | 321                     | 270                              | <0.01            | 2                | 0.85             | 62.5                             | 259                              |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba    | Cd     | Co  | Cr     | Cu     | Fe     | Hg     | Mn     | Ni     | Pb     | Sb     | HARDNESS CALC. Zn (mg CaCO3/L) |
|-------------|--------|-------|--------|-----|--------|--------|--------|--------|--------|--------|--------|--------|--------------------------------|
| 47-028-GW-1 | 1.88   | 12.4  | 4.59 U | 5 U | 6.24 U | 2.33 U | 116    | 0.12 U | 10     | 10.9 U | 1.12   | 31.7 U | 8.71 U 211                     |
| 47-028-SW-1 | 1.63   | 13    | 4.59 U | 5 U | 6.24 U | 2.33 U | 107    | 0.35   | 6.3    | 10.9 U | 1.19   | 31.7 U | 8.71 U 206                     |
| 47-028-SW-2 | 1.12 U | 1.1 U | 4.59 U | 5 U | 6.24 U | 2.33 U | 13.7 U | 0.12 U | 3.76 U | 10.9 U | 0.94 U | 31.7 U | 8.71 U 0.1                     |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 47-028-GW-1 | 178                    | < 5      | 15      | 0.18      | NR      |
| 47-028-SW-1 | 210                    | < 5      | 16      | 0.15      | NR      |
| 47-028-SW-2 | NR                     | NR       | NR      | NR        | < 0.01  |

**LEGEND**

SE1 - At adit discharge below Moose Creek road.

WR1 - Composite of subsamples WR1A, 1B, and 1C.

BACKGROUND - From the Highland Mine (47-028-SS-1).

GW1 - Adit #1 discharge.

SW1 - Adit discharge below Moose Creek road.

SW2 - QA/QC Blank.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Mary Emme/Clinton</u>              | County: <u>Silver Bow</u>                  |
| Legal Description: <u>T 3N R 7W</u>                   | Section(s): <u>NE 1/4, SW 1/4, Sec. 10</u> |
| Mining District: <u>Elk Park-Butte</u>                | Mine Type: <u>Hardrock/Unknown</u>         |
| Latitude: <u>N 46° 01' 17"</u>                        | Primary Drainage: <u>Silver Bow Creek</u>  |
| Longitude: <u>W 112° 27' 14"</u>                      | USGS Code: <u>17010201</u>                 |
| Land Status: <u>Private</u>                           | Secondary Drainage: <u>Woodville Gulch</u> |
| Quad: <u>Elk Park Pass</u>                            | Date: <u>August 20, 1993</u>               |
| Inspectors: <u>Babits, Flammang, Lasher</u>           | P.A. # <u>47-035</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no mill tailings associated with site.
- There were approximately 66,620 cubic yards of uncovered waste rock on site. The following elements were elevated at least three times background:  
Mercury: 1.27 mg/kg                      Lead: 834 to 1,670 mg/kg  
Antimony: 61.8 to 235 mg/kg
- There was one discharging adit at the site which entered Woodville Gulch. A sample of this discharge had a pH of 5.40, and MCLs were exceeded for arsenic, cadmium, and lead. The chronic fresh water aquatic life criteria for iron and lead was exceeded. The acute fresh water aquatic life criteria for cadmium was exceeded, and the chronic and acute fresh water aquatic life criteria for copper and zinc were exceeded.
- Woodville Gulch flowed approximately 100 feet from the waste rock. There were no observed releases to downstream surface water or sediment. Cadmium and copper exceeded MCLs, and the acute fresh water aquatic life criteria for cadmium was exceeded in downstream surface water samples. The acute and chronic fresh water aquatic life criteria for copper and zinc were also exceeded in downstream surface water.
- There were three open shafts at the site.



**Mary Emmee/ Clinton PA# 47-035**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/20/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 47-035-SE-1 | 110           | 205 J         | 29 J          | 13.5 U        | 10.2          | 1230          | 9470          | 0.232 U       | 480 J         | 17.6 U        | 119           | 42.6 U        | 4420 J        | NR                 |
| 47-035-SE-2 | 48.8          | 39 J          | 1.2 U         | 7.65 J        | 12.7          | 347           | 26400         | 0.062 U       | 762 J         | 5.69 U        | 91.8          | 13.8 U        | 577 J         | NR                 |
| 47-035-WR-2 | 263           | 45.1 J        | 0.4 U         | 4.67 J        | 2.33          | 365           | 33300         | 1.27          | 144 J         | 3.07          | 1670          | 235           | 1200 J        | NR                 |
| 47-035-WR-1 | 216           | 23.4 J        | 1.8 J         | 2.09 U        | 1.47 U        | 422           | 17600         | 0.833         | 51.5 J        | 2.72 U        | 834           | 61.8          | 865 J         | NR                 |
| BACKGROUND  | 143           | 228 J         | 3.7 J         | 9.72 J        | 6.81          | 447           | 20200         | 0.177         | 480 J         | 3.84          | 156           | 6.01 U        | 911 J         | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|----------------------|---|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 47-035-WR-1 | 1.04                 | 32.5                                    | -4                            | -37                                       | 0.49                   | 0.09                   | 0.46                   | 2.81                                      | -6.58                                     |
| 47-035-WR-2 | 2.45                 | 76.5                                    | -1.1                          | -78                                       | 0.69                   | 0.66                   | 1.1                    | 20.6                                      | -21.7                                     |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba     | Cd     | Co    | Cr     | Cu     | Fe      | Hg     | Mn   | Ni     | Pb   | Sb     | Zn (mg CaCO3/L) | HARDNESS<br>CALC. |
|-------------|--------|--------|--------|-------|--------|--------|---------|--------|------|--------|------|--------|-----------------|-------------------|
| 47-035-SW-1 | 3.89 J | 33.4   | 2.57 U | 9.7 U | 6.83 U | 13.3 J | 64.3 J  | 0.12 U | 12.7 | 12.7 U | 1.56 | 30.7 U | 248             | 60.3              |
| 47-035-SW-2 | 1.69 U | 21.9   | 27.9   | 16.9  | 6.83 U | 2670 J | 863 J   | 0.12 U | 2590 | 12.7 U | 4    | 30.7 U | 7970            | 136               |
| 47-035-SW-3 | 65.6 J | 2.01 U | 29.7   | 9.7 U | 6.83 U | 1260 J | 19100 J | 0.12 U | 2120 | 12.7 U | 28.6 | 30.7 U | 4710            | 84.7              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL<br>DISSOLVED<br>SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------------|----------|---------|-----------|---------|
| 47-035-SW-1 | 148                          | < 5.0    | 29      | < 0.05    | NR      |
| 47-035-SW-2 | 432                          | < 5.0    | 281     | < 0.05    | NR      |
| 47-035-SW-3 | 8                            | < 5.0    | 134     | < 0.05    | NR      |

**LEGEND**

SE1 - Upgradient of tributary approx. 50' above waste rock dump 1.  
 SE2 - 10' above where tributary enters culvert going under freeway.  
 WR1 - Composite of subsamples WR1A, 1B, and 1C.  
 WR2 - Composite of subsamples WR2, 3A, 3B, 3C, 4A, and 4B.  
 BACKGROUND - From Mary Emmee/Clinton Mine (47-035-SS-1).

SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.  
 SW3 - Adit discharge of waste rock dump 1.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |  |
|--|--|
| Mine/Site Name: <u>Rising Sun</u>  | County: <u>Silver Bow</u>                    |
| Legal Description: T <u>3N</u> R <u>7W</u>   | Section(s): <u>NE 1/4, SW 1/4, Sec. 22</u>   |
| Mining District: <u>Elk Park</u>   | Mine Type: <u>Hardrock/Ag. Cu</u>            |
| Latitude: <u>N 45° 59' 47"</u>   | Primary Drainage: <u>Silver Bow Creek</u>    |
| Longitude: <u>W 112° 27' 27"</u>   | USGS Code: <u>17010201</u>                   |
| Land Status: <u>Private/Public</u>   | Secondary Drainage: <u>Tramway Gulch</u>     |
| Quad: <u>Homestake</u>   | Date Investigated: <u>September 14, 1993</u> |
| Inspectors: <u>Bullock/Pierson</u>   | P.A. # <u>47-037</u>                         |
| Organization: <u>Pioneer Technical Services,<br/>Inc./Thomas, Dean and Hoskins, Inc.</u> |  |

- There were no mill tailings observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 2,000 cubic yards. The only element elevated at least three times background was mercury (0.661J mg/kg).
- One adit discharge was present at this site with a flow of approximately 20 gpm and a pH of 7.28. No MCL/MCLGs or acute or chronic aquatic life criteria were exceeded in the adit discharge.
- The adit discharge served as the headwaters for the stream associated with Tramway Gulch. No other surface water was observed on or near the site.
- The adit opening was identified as a potential safety hazard. Recreation use in the area appeared to be high.

**Rising Sun PA# 47-037**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 09/14/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 47-037-WR-1 | 10 J       | 83.2       | 0.86 U     | 7.71       | 4.89       | 24.5       | 13500      | 0.661 J    | 311        | 4.04       | 9.26       | 5.9 UJ     | 37         | NR              |
| BACKGROUND  | 143        | 228 J      | 3.7 J      | 9.72 J     | 6.81       | 447        | 20200      | 0.177      | 480 J      | 3.84       | 156        | 6.01 U     | 911 J      | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 47-037-WR-1 | 0.01           | 0.31                           | 13.6                    | 13.3                             | <0.01            | <0.01            | 0.01             | 0                                | 13.6                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co  | Cr     | Cu     | Fe     | Hg     | Mn     | Ni     | Pb      | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|------|--------|-----|--------|--------|--------|--------|--------|--------|---------|--------|-----------------|----------------|
| 47-037-GW-1 | 3.06 | 15.1 | 4.59 U | 5 U | 6.24 U | 2.33 U | 13.7 U | 0.12 U | 3.76 U | 10.9 U | 1.22 UJ | 31.7 U | 8.71 U          | 98.6           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD<br>I.D. | TOTAL<br>DISSOLVED<br>SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|---------------|------------------------------|----------|---------|-----------|---------|
| 47-037-GW-1   | 180                          | < 5      | 33      | 0.12      | NR      |

**LEGEND**

WR1 - Composite of subsamples WR1A, 1B, and 1C.

GW1 - Open, discharging adit #1.

BACKGROUND - From the Mary Emme/Clinton Mine (47-035-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

Mine/Site Name: Old Glory  
Legal Description: T 1S R 8W  
Mining District: Melrose  
Latitude: N 45° 42' 40"  
Longitude: W 112° 38' 38"  
Land Status: Private  
Quad: Melrose  
Inspectors: Bullock, Tuesday  
Organization: Pioneer Technical Services, Inc.

County: Silver Bow  
Section(s): NW 1/4, NW 1/4, Sec. 31  
Mine Type: Hardrock/Ag, Au, Cu  
Primary Drainage: Soap Gulch  
USGS Code: 10020004  
Secondary Drainage: Soap Gulch  
Date Investigated: August 24, 1993  
P.A. # 47-027

- No mill tailings were associated with this site.
- The volume of waste material at the site was estimated to be 10,025 cubic yards. The following elements were elevated at least three times background:

|                        |                         |
|------------------------|-------------------------|
| Arsenic: 843 mg/kg     | Cadmium: 6.2 mg/kg      |
| Mercury: 0.608J mg/kg  | Manganese: 11,600 mg/kg |
| Nickel: 92.1J mg/kg    | Lead: 254 mg/kg         |
| Antimony: 12.6J mg/kg. |                         |
- The waste rock dumps were unvegetated.
- No discharging adits, seeps, or springs were observed.
- No surface water samples were collected as there was no surface water on or near the site.
- Hazards present at the site during the investigation included an old cabin near the shaft, and unstable slopes around the collapsed shaft.



**Old Glory PA# 47-027**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/24/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 47-027-WR-1 | 843           | 414 J         | 6.2           | 36.9          | 4.38          | 69.3          | 28300         | 0.608 J       | 11600         | 92.1 J        | 254           | 12.6 J        | 354           | NR                 |
| BACKGROUND  | 56            | 169           | 0.8 JX        | 13.8          | 29.4          | 34.2          | 25300         | 0.014 U       | 462           | 26            | 30            | 4 UJ          | 119           | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>1/1000t | NEUTRAL<br>POTENT.<br>1/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>1/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>1/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>1/1000t |
|-------------|----------------------|---|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 47-027-WR-1 | 0.12                 | 3.75                                    | 5.06                          | 1.31                                      | 0.12                   | <0.01                  | 0.01                   | 0   | 5.06                                      |

**LEGEND**

WR1 - Composite of subsamples WR1A, 1B, 2, and 3.  
BACKGROUND - From the Emma Mine (29-061-SS-1).

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Clipper</u>                        | County: <u>Silver Bow</u>                  |
| Legal Description: T <u>1S</u> R <u>8W</u>            | Section(s): <u>NE 1/4, NW 1/4, Sec. 26</u> |
| Mining District: <u>Melrose</u>                       | Mine Type: <u>Hardrock/Cu</u>              |
| Latitude: <u>N 45° 43' 30"</u>                        | Primary Drainage: <u>Camp Creek</u>        |
| Longitude: <u>W 112° 33' 35"</u>                      | USGS Code: <u>10020004</u>                 |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Wickiup Creek</u>   |
| Quad: <u>Wickiup Creek</u>                            | Date Investigated: <u>August 24, 1993</u>  |
| Inspectors: <u>Bullock, Tuesday</u>                   | P.A. # <u>47-029</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no mill tailings observed at this site during the investigation.
- The volume of waste rock associated with this site was estimated to be approximately 6,255 cubic yards. The following elements were elevated at least three times background:

|                              |                                 |
|------------------------------|---------------------------------|
| Arsenic: 177 to 236 mg/kg    | Cobalt: 86 mg/kg                |
| Copper: 1290 to 19,100 mg/kg | Mercury: 0.219J to 0.293J mg/kg |
| Lead: 389 to 979 mg/kg       | Antimony: 274J mg/kg            |
- One discharging adit was identified at the site. The MCL for copper was exceeded in the adit discharge. Also, the acute and chronic aquatic life criteria for copper and chronic aquatic life criteria for mercury and lead were exceeded in the adit discharge.
- Upstream and downstream surface water samples were collected from Wickiup Creek. No MCLs were exceeded in either of the samples; however, chronic aquatic life criteria were exceeded for mercury and lead in both the upstream and downstream samples. Acute and chronic aquatic life criteria were exceeded for copper in the downstream sample.
- An observed release to Wickiup Creek was documented for copper. The acute and chronic aquatic life criteria exceedances for copper in Wickiup Creek were directly attributable to the site. Additionally, concentrations of arsenic, cobalt, copper, and lead were significantly elevated (greater than three times) in the downstream sediment sample when compared to the upstream sediment sample.
- Two potentially hazardous mine openings were identified at the site including a fenced shaft and an open adit.

**Clipper PA# 47-029**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/24/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 47-029-SE-1 | 44.4       | 20.4 J     | 1.1 U      | 18.4       | 6.72       | 1650       | 32400      | 0.031 U    | 85.5       | 13.6 J     | 41.8       | 7.26 UJ    | 43.7       | NR              |
| 47-029-SE-2 | 10.4       | 29.4 J     | 0.8 U      | 5.02       | 8.09       | 12.7       | 17800      | 0.034 U    | 181        | 11.8 J     | 5.43 U     | 5.24 UJ    | 27.3       | NR              |
| 47-029-WR-1 | 236        | 2.79 J     | 0.8 U      | 2.45       | 3.04       | 1290       | 27100      | 0.219 J    | 20.2       | 3.37 J     | 389        | 5.67 UJ    | 14.6       | NR              |
| 47-029-WR-2 | 177        | 15.4 J     | 1.4        | 86         | 9.37       | 19100      | 39400      | 0.293 J    | 609        | 18.2 J     | 979        | 274 J      | 87.3       | NR              |
| BACKGROUND  | 56         | 169        | 0.8 JX     | 13.8       | 29.4       | 34.2       | 25300      | 0.014 U    | 462        | 26         | 30         | 4 UJ       | 119        | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 47-029-WR-1 | 0.92           | 28.7                           | -0.3                     | -29                              | 0.76             | 0.03             | 0.13             | 0.94                             | -1.23                            |
| 47-029-WR-2 | 0.12           | 3.75                           | 2.62                     | -1.1                             | 0.06             | <0.01            | 0.06             | 0.00                             | 2.62                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co    | Cr     | Cu     | Fe  | Hg      | Mn   | Ni   | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|------|--------|-------|--------|--------|-----|---------|------|------|--------|--------|-----------------|----------------|
| 47-029-GW-1 | 1.97 | 4.93 | 2.57 U | 43.3  | 6.83 U | 3050   | 725 | 0.18 JX | 165  | 25.3 | 4.29 J | 30.7 U | 52.6 J          | 68.9           |
| 47-029-SW-1 | 2.18 | 8.03 | 2.57 U | 9.7 U | 10.3 J | 206    | 291 | 0.45 JX | 37.6 | 12.9 | 2.72 J | 30.7 U | 7.9 J           | 57.2           |
| 47-029-SW-2 | 2.67 | 7.73 | 2.57 U | 9.7 U | 6.83 U | 1.55 U | 102 | 0.16 JX | 8.2  | 20   | 3.52 J | 30.7 U | 13.1 J          | 52.9           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 47-029-GW-1 | 131                    | < 5.0    | 40      | 0.11      | NR      |
| 47-029-SW-1 | 106                    | < 5.0    | 15      | < 0.05    | NR      |
| 47-029-SW-2 | 107                    | < 5.0    | 11      | < 0.05    | NR      |

**LEGEND**

SE1 - Downstream from mine site in Wickiup Creek.  
SE2 - Upstream from mine in Wickiup Creek.  
WR1 - Composite of subsamples WR1A, 1B, 1C, and 2.  
WR2 - Composite of subsamples WR3, 5, and 6.  
BACKGROUND - From the Emma Mine (29-061-SS-1).

GW1 - Adit #1 discharge.  
SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Maiden Rock</u>                    | County: <u>Silver Bow</u>                 |
| Legal Description: <u>T 2S R 9W</u>                   | Section(s): <u>NE 1/4, NE 1/4, Sec. 5</u> |
| Mining District: <u>Melrose</u>                       | Mine Type: <u>Open Pit/P</u>              |
| Latitude: <u>N 45° 41' 42"</u>                        | Primary Drainage: <u>Big Hole River</u>   |
| Longitude: <u>W 112° 44' 03"</u>                      | USGS Code: <u>10020004</u>                |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Big Hole River</u> |
| Quad: <u>Melrose</u>                                  | Date Investigated: <u>August 24, 1993</u> |
| Inspectors: <u>Bullock, Tuesday</u>                   | P.A. # <u>47-051</u>                      |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- Small historic mine workings were identified above the active Rhone-Poulenc phosphorous pit and milling facility. The workings were insignificant compared to the active crushing facility below and the open pit mining operation located across the Big Hole River. No samples were collected due to the active status of the site. The site should be inventoried if active mining operations cease.





**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Middle Fork Millsite</u>           | County: <u>Silver Bow</u>                        |
| Legal Description: T <u>1N</u> R <u>8W</u>            | Section(s): <u>SW 1/4, SE 1/4, Sec. 36</u>       |
| Mining District: <u>Moose Creek</u>                   | Mine Type: <u>mill tailings/Au</u>               |
| Latitude: <u>N 46° 47' 15"</u>                        | Primary Drainage: <u>Moose Creek</u>             |
| Longitude: <u>W 112° 33' 10"</u>                      | USGS Code: <u>10020004</u>                       |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Middle Fork Moose Ck.</u> |
| Quad: <u>Mount Humbug</u>                             | Date Investigated: <u>August 27, 1993</u>        |
| Inspectors: <u>Bullock, Tuesday</u>                   | P.A. # <u>47-081</u>                             |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- The volume of mill tailings associated with this site was estimated to be 36,500 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 261J to 265J mg/kg      Copper: 783 to 1120 mg/kg  
Iron: 70,700 to 106,000 mg/kg      Mercury: 0.705J to 0.93J mg/kg  
Lead: 62 to 195 mg/kg      Zinc: 241 mg/kg
- There was no waste rock associated with this site.
- There were no discharges associated with mine openings at this site. Several seeps were identified associated with small tributaries to Moose Creek.
- Moose Creek was sample upstream and downstream of this site. The water samples documented an observed release of iron, attributable to this site. Sampling did not document exceedances of MCL/MCLGs or aquatic life criteria attributable to this site. Stream sediment samples documented observed releases of arsenic, copper, iron, mercury, lead, and zinc.
- Level areas of the tailings impoundments were well vegetated, except where disturbed by cattle grazing.

**Middle Fork Millsite PA# 47-081**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/27/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 47-081-SE-1 | 418 J      | 204        | 2.59 J     | 27.8       | 14.3       | 993        | 127000     | 0.546 J    | 6420       | 20         | 109        | 14.8 U     | 249        | NR              |
| 47-081-SE-2 | 1080 J     | 259        | 9.08 J     | 19.1       | 7.27 U     | 393        | 221000     | 0.805 J    | 2070       | 13.5       | 75.1       | 36.9 U     | 635        | NR              |
| 47-081-SE-3 | 12.5 J     | 96.3       | 0.99 U     | 5.56       | 7.05       | 14.5       | 8490       | 0.126 J    | 349        | 8.54       | 7.05 U     | 6.8 U      | 24.1       | NR              |
| 47-081-TP-1 | 261 J      | 29.5       | 1.52 J     | 6.68       | 15.5       | 783        | 70700      | 0.93 J     | 213        | 5.73       | 62         | 7.16       | 155        | NR              |
| 47-081-TP-2 | 265 J      | 40         | 2.47 J     | 13.5       | 10.7       | 1120       | 106000     | 0.705 J    | 432        | 7.99       | 195        | 7.71 U     | 241        | NR              |
| BACKGROUND  | 40.1 J     | 173 J      | 1 U        | 10.1       | 21.1 J     | 34.3       | 18500 JX   | 0.039 J    | 832        | 18.1       | 14.8       | 7.28 UJ    | 61.9 J     | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 47-081-TP-1 | 1.15           | 35.9                           | 98.3                     | 62.4                             | 0.78             | 0.27             | 0.1              | 8.43                             | 89.9                             |
| 47-081-TP-2 | 3              | 93.7                           | 56.4                     | -37                              | <0.01            | 2.83             | 0.37             | 88.4                             | -32                              |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co  | Cr     | Cu     | Fe     | Hg   | Mn   | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|------|--------|-----|--------|--------|--------|------|------|--------|--------|--------|-----------------|----------------|
| 47-081-SW-1 | 4.15 | 30   | 4.59 U | 5 U | 6.24 U | 9.23 J | 467 J  | 0.21 | 49.9 | 10.9 U | 2.1    | 31.7 U | 8.71 U          | 295            |
| 47-081-SW-2 | 3.03 | 24.5 | 4.59 U | 5 U | 6.24 U | 5.73 J | 371 J  | 0.21 | 27.6 | 10.9 U | 0.94 U | 31.7 U | 8.71 U          | 209            |
| 47-081-SW-3 | 3.53 | 37.9 | 4.59 U | 5 U | 6.24 U | 10.6 J | 46.7 J | 0.19 | 30.9 | 10.9 U | 0.94 U | 31.7 U | 8.71 U          | 219            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 47-081-SW-1 | 329                    | < 5.0    | 57      | < 0.05    | NR      |
| 47-081-SW-2 | 285                    | < 5.0    | 52      | < 0.05    | NR      |
| 47-081-SW-3 | 272                    | < 5.0    | 7       | < 0.05    | NR      |

**LEGEND**

SE1 - Downstream below lowest tailings pond.  
SE2 - Intermediate sample on tributary between mill and tailings.  
SE3 - Upgradient on Middle Fork Moose Creek.  
TP1 - Composite of subsamples TP1, 2A-A, 2A-B, and 2A-C.  
TP2 - Composite of subsamples TP3A-A, 3A-B, and 4.  
BACKGROUND - From the Highland Mine (47-028-SS-1).

SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.  
SW3 - Same as sample SE3.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|  |  |
|--|--|
| Mine/Site Name: <u>Mouat Mine</u>                | County: <u>Stillwater</u>                      |
| Legal Description: T <u>5S</u> R <u>15E</u>      | Section(s): <u>NW 1/4, Sec. 20</u>             |
| Mining District: <u>Nye</u>                      | Mine Type: <u>Hardrock/Cr</u>                  |
| Latitude: <u>N 45° 23' 20"</u>                   | Primary Drainage: <u>Stillwater River</u>      |
| Longitude: <u>W 109° 54' 03"</u>                 | USGS Code: <u>10070005</u>                     |
| Land Status: <u>Public</u>                       | Secondary Drainage: <u>Mountain View Creek</u> |
| Quad: <u>Meyer Mountain</u>                      | Date Investigated: <u>August 24, 1993</u>      |
| Inspectors: <u>Babits, Flammang/Pierson</u>      | P.A. # <u>48-001</u>                           |
| Organization: <u>Pioneer Technical Services,</u> |  |
| <u>Inc./ Thomas, Dean and Hoskins, Inc.</u>      |  |

- There were no mill tailings associated with this site.
- There were approximately 90,400 cubic yards of uncovered waste rock on site. The following were elevated at least three times background:  
Mercury: 0.146J to 0.25J mg/kg
- There was one discharging adit on site, but it did not enter surface water directly. The pH of the discharge was 8.05, and no MCL/MCLGs were exceeded.
- A lake was approximately 750 feet from the site. A sample was collected in the lake prior to its discharge to the Mountain View Creek. No MCL/MCLGs were exceeded. The chronic fresh water aquatic life criteria for cadmium, mercury, and lead were exceeded in downstream surface water.
- There was one open adit and at least 12 hazardous structures on site.



**Mouat Mine PA# 48-001**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/24/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 48-001-SE-2 | 4.29 U     | 7.79 J     | 0.8 U      | 11         | 82.6       | 18.5       | 10900      | 0.028 U    | 105        | 123 J      | 5.89 U     | 5.68 UJ    | 15.7       | NR              |
| 48-001-WR-1 | 4.42 U     | 3.22 J     | 1.1        | 80.5       | 51.8       | 22.8       | 46600      | 0.25 J     | 696        | 943 J      | 6.06 U     | 5.85 UJ    | 28.3       | NR              |
| 48-001-WR-2 | 4.85 U     | 12.4 J     | 1.2        | 66.3       | 66         | 23.4       | 38100      | 0.146 J    | 569        | 770 J      | 6.64 U     | 6.41 UJ    | 22.3       | NR              |
| 48-001-WR-3 | 4.7 U      | 3.8 J      | 0.9 U      | 39.5       | 103        | 22.1       | 23500      | 0.185 J    | 384        | 489 J      | 6.44 U     | 6.22 UJ    | 14.4       | NR              |
| BACKGROUND  | 4.27 U     | 30.7 J     | 0.8 U      | 54         | 147        | 18.5       | 33400      | 0.028 U    | 668        | 551 J      | 5.85 U     | 5.65 UJ    | 25.8       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL. POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|--------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 48-001-WR-1 | <0.01          | 0                              | 37.5                     | 37.5                             | <0.01            | <0.01            | <0.01            | 0                                | 37.5                             |
| 48-001-WR-2 | <0.01          | 0                              | 37.8                     | 37.8                             | <0.01            | 0.01             | <0.01            | 0.31                             | 37.5                             |
| 48-001-WR-3 | <0.01          | 0                              | 11.3                     | <0 11.3                          | <0.01            | <0.01            | 0.01             | 0                                | 11.3                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As     | Ba     | Cd     | Co    | Cr     | Cu     | Fe   | Hg      | Mn     | Ni     | Pb     | Sb     | HARDNESS CALC. Zn (mg CaCO3/L) |
|-------------|--------|--------|--------|-------|--------|--------|------|---------|--------|--------|--------|--------|--------------------------------|
| 48-001-SW-1 | 0.96 U | 2.01 U | 2.57 U | 9.7 U | 18.1 J | 1.57   | 21.6 | 0.14 JX | 4.08 U | 12.7 U | 3.62 J | 30.7 U | 7.57 U 121                     |
| 48-001-SW-2 | 0.96 U | 2.01 U | 2.57 U | 9.7 U | 12.3 J | 1.55 U | 135  | 0.19 JX | 14.6   | 12.7 U | 3.14 J | 30.7 U | 8.37 J 70.6                    |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD I.D.  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 48-001-SW-1 | 149                    | <        | 5.0     | 14        | 0.24 NR |
| 48-001-SW-2 | 97                     | <        | 5.0     | 5         | NR NR   |

**LEGEND**

SE2 - Mountain View Lake just prior to discharge.  
 WR1 - Composite of subsamples WR1A and 1C.  
 WR2 - Composite of subsamples WR1B, 1C, 2A, and 2B.  
 WR3 - Composite of subsamples WR3A, 3B, 3C, 4, and 5.  
 BACKGROUND - From the Mouat Mine (48-001-SS-1).

SW1 - Adit discharge.  
 SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |   |
|---|---|
| Mine/Site Name: <u>Benbow Millsite</u>                | County: <u>Stillwater</u>                     |
| Legal Description: <u>T 5S R 16E</u>                  | Section(s): <u>NW 1/4, Sec. 21</u>            |
| Mining District: <u>Stillwater</u>                    | Mine Type: <u>Hardrock/Cr, Fe, Ni</u>         |
| Latitude: <u>N 45° 23' 20"</u>                        | Primary Drainage: <u>Stillwater River</u>     |
| Longitude: <u>W 109° 45' 55"</u>                      | USGS Code: <u>10070005</u>                    |
| Land Status: <u>Public</u>                            | Secondary Drainage: <u>Little Rocky Creek</u> |
| Quad: <u>Nye</u>                                      | Date Investigated: <u>August 11, 1993</u>     |
| Inspectors: <u>Babits, Flammang, Lasher</u>           | P.A. # <u>48-005</u>                          |
| Organization: <u>Pioneer Technical Services, Inc.</u> |   |

- There were approximately 5,950 cubic yards of mostly covered mill tailings at the site. The following were elevated at least three times background:

|                               |                            |
|-------------------------------|----------------------------|
| Cadmium: 1.08J to 1.60J mg/kg | Cobalt: 44.7 to 68.3 mg/kg |
| Chromium: 66.8 to 908 mg/kg   | Mercury: 0.199 mg/kg       |
| Nickel: 72.3 to 983 mg/kg     |                            |
- There was no waste rock associated with this site.
- There were no discharging adits at the site.
- An unnamed tributary of Little Rocky Creek flowed adjacent to the tailings. There were observed releases of cobalt, chromium, and nickel in downstream sediment, and there were no observed releases to downstream surface water. No MCL/MCLGs or fresh water aquatic life criteria were exceeded in downstream surface water.
- A conveyor gallery in the mill was partially open and hazardous and the mill wall is 20 feet high.

**Benbow Millsite PA# 48-005**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BABITS**  
**INVESTIGATION DATE: 08/11/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 48-005-SE-1 | 6.77 U     | 71         | 0.74 U     | 5.62       | 46 J       | 13.9       | 7060       | 0.051 U    | 183        | 23.9       | 11.6 U     | 8.82 UJ    | 39.4       | NR              |
| 48-005-SE-2 | 5.38 U     | 16.1       | 0.59 U     | 34.7       | 497 J      | 13.3       | 25200      | 0.102      | 625        | 531        | 9.22 U     | 7 UJ       | 13.9       | NR              |
| 48-005-SE-3 | 11.4 U     | 85.9 J     | 1.25 UJ    | 16.5       | 160        | 33.9       | 21600      | 0.088 U    | 511        | 134        | 38.8       | 14.9 UJ    | 68.6       | NR              |
| 48-005-SE-4 | 4.76 U     | 22 J       | 0.52 UJ    | 44.7       | 495        | 16.1       | 34800      | 0.034 U    | 687        | 668        | 8.16 U     | 6.2 UJ     | 25.9       | NR              |
| 48-005-TP-1 | 5.18 U     | 9.25 J     | 1.08 J     | 68.3       | 908        | 26         | 43700      | 0.199      | 1040       | 953        | 8.88 U     | 6.74 UJ    | 25.6       | NR              |
| 48-005-TP-2 | 4.12 U     | 5.36 J     | 1.60 J     | 67.4       | 715        | 16.1       | 44800      | 0.03 U     | 754        | 983        | 7.06 U     | 5.36 UJ    | 24.9       | NR              |
| 48-005-TP-3 | 8.66       | 134 J      | 0.56 UJ    | 11.6       | 66.8       | 13.5       | 20700      | 0.034 U    | 806        | 72.3       | 16.4       | 6.68 UJ    | 58.7       | NR              |
| BACKGROUND  | 14.8 J     | 97.1       | 0.54 U     | 6.45       | 10.8 J     | 12.9       | 21100      | 0.051      | 381        | 11.5       | 11.8       | 6.41 UJ    | 58.1       | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID       | TOTAL SULFUR % | TOTAL SULFUR ACID BASE $\mu/1000t$ | NEUTRAL POTENT. $\mu/1000t$ | SULFUR ACID BASE POTENT. $\mu/1000t$ | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE $\mu/1000t$ | SULFUR ACID BASE POTENT. $\mu/1000t$ |
|----------------|----------------|------------------------------------|-----------------------------|--------------------------------------|------------------|------------------|------------------|--------------------------------------|--------------------------------------|
| 48-005-TP-1    | 0.04           | 1.25                               | 108                         | 107                                  | <0.01            | 0.01             | 0.03             | 0.31                                 | 108                                  |
| 48-005-TP-1DUP | 0.04           | 1.25                               | 109                         | 108                                  | 0.01             | <0.01            | 0.04             | 0.00                                 | 109                                  |
| 48-005-TP-2    | 0.01           | 0.31                               | 87.3                        | 87.0                                 | <0.01            | <0.01            | 0.01             | 0.00                                 | 87.3                                 |
| 48-005-TP-3    | 0.03           | 0.94                               | 10.3                        | 9.35                                 | <0.01            | 0.01             | 0.03             | 0.31                                 | 9.97                                 |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in  $\mu g/L$

| FIELD ID    | As     | Ba   | Cd     | Co    | Cr     | Cu   | Fe  | Hg     | Mn   | Ni     | Pb     | Sb     | Zn (mg $CaCO_3/L$ ) | HARDNESS CALC. |
|-------------|--------|------|--------|-------|--------|------|-----|--------|------|--------|--------|--------|---------------------|----------------|
| 48-005-SW-1 | 1.18 U | 26.3 | 2.57 U | 9.7 U | 6.83 U | 2.03 | 112 | 0.16   | 4.13 | 12.7 U | 1.09 J | 30.7 U | 11.7                | 83             |
| 48-005-SW-2 | 1.19   | 41.3 | 2.57 U | 9.7 U | 8.6    | 1.7  | 645 | 0.12 U | 60.4 | 12.7 U | 1.23 J | 30.7 U | 7.57 U              | 139            |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD I.D.  | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 48-005-SW-1 | 123                    | < 5.0    | 14      | < 0.05    | NR      |
| 48-005-SW-2 | 169                    | < 5.0    | 7       | < 0.05    | NR      |

**LEGEND**

SE1 - In unnamed trib. N of road crossing.  
SE2 - In unnamed trib. at base of tailings pond 2.  
SE3 - In Little Rocky Creek, 50' upstream of confluence with unnamed tributary.  
SE4 - In Little Rocky Creek, 50' downstream of confluence with unnamed tributary.  
TP1 - Composite of subsamples TP1AA, 1BA, and 1BB.  
TP2 - Composite of subsamples TP2AA, 2AB, and 2BA.  
TP3 - Sample of the TP2BB subsample.

BACKGROUND - From the Benbow Millsite (48-005-SS-1).  
SW1 - Same as sample SE1.  
SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Poorman/Emma</u>                   | County: <u>Sweetgrass</u>                        |
| Legal Description: <u>T 7S R 12E</u>                  | Section(s): <u>SW 1/4, NE 1/4, Sec. 22</u>       |
| Mining District: <u>Independence</u>                  | Mine Type: <u>Hardrock/Au, Ag</u>                |
| Latitude: <u>N 45° 12' 43"</u>                        | Primary Drainage: <u>East Fork Boulder River</u> |
| Longitude: <u>W 110° 13' 46"</u>                      | USGS Code: <u>10070002</u>                       |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Unnamed Tributary</u>     |
| Quad: <u>Haystack Peak</u>                            | Date Investigated: <u>August 11, 1993</u>        |
| Inspectors: <u>Bullock, Belanger, Clark</u>           | P.A. # <u>49-001</u>                             |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no mill tailings observed at the site.
- The volume of waste rock associated with this site was estimated to be 245 cubic yards. The following elements were elevated at least three times background:

|                      |                   |
|----------------------|-------------------|
| Arsenic: 270 mg/kg   | Copper: 292 mg/kg |
| Mercury: 0.323 mg/kg | Lead: 399 mg/kg.  |
- The waste rock dumps were unvegetated.
- One partially flooded shaft was present with a pH of 6.20 and a specific conductance of 230 umhos/cm. The water did not exceed MCL/MCLGs. No seeps or springs were observed during the site visit.
- It was approximately 200 feet from the waste rock to the nearest drainage with no direct runoff pathways observed.
- The flooded shaft was open and potentially hazardous, as were two wood cabins present on the site.



**Poor Man/ Emma PA# 49-001**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/11/93**

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Co (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 49-001-WR-1 | 270        | 103 J      | 1.57 J     | 24.6       | 21.5       | 292        | 27800      | 0.323      | 637        | 42.5       | 399        | 5.79 UJ    | 273        | NR              |
| BACKGROUND  | 16.3       | 78.3 J     | 0.68 J     | 13.5       | 45.6       | 40.1       | 28500      | 0.064      | 612        | 24         | 37.2       | 7.97 UJ    | 99         | NR              |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL SULFUR % | TOTAL SULFUR ACID BASE t/1000t | NEUTRAL POTENT. t/1000t | SULFUR ACID BASE POTENT. t/1000t | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC SULFUR ACID BASE t/1000t | SULFUR ACID BASE POTENT. t/1000t |
|-------------|----------------|--------------------------------|-------------------------|----------------------------------|------------------|------------------|------------------|----------------------------------|----------------------------------|
| 49-001-WR-1 | 0.07           | 2.19                           | 8.60                    | 6.42                             | 0.03             | <0.01            | 0.04             | 0.00                             | 8.60                             |

**WATER MATRIX ANALYSES**

Metals in Water  
Results in ug/L

| FIELD ID    | As   | Ba   | Cd     | Co    | Cr     | Cu    | Fe   | Hg      | Mn     | Ni     | Pb     | Sb     | Zn (mg CaCO3/L) | HARDNESS CALC. |
|-------------|------|------|--------|-------|--------|-------|------|---------|--------|--------|--------|--------|-----------------|----------------|
| 49-001-GW-1 | 2.03 | 19   | 2.57 U | 9.7 U | 6.83 U | 3.2   | 22.8 | 0.12 U  | 36.2   | 12.7 U | 1.07 J | 30.7 U | 10.3            | 19.3           |
| 49-001-GW-2 | 4.2  | 17.1 | 2.57 U | 9.7 U | 6.83 U | 1.9 J | 48.2 | 0.120 U | 4.08 U | 12.7 U | 0.72 U | 30.7 U | 7.57 U          | 18.4           |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Wet Chemistry  
Results in mg/l

| FIELD ID    | TOTAL DISSOLVED SOLIDS | CHLORIDE | SULFATE | NO3/NO2-N | CYANIDE |
|-------------|------------------------|----------|---------|-----------|---------|
| 49-001-GW-1 | 56                     | 5.0      | 9       | 0.05      | NR      |
| 49-001-GW-2 | 61                     | 5.0      | 6       | 0.06      | NR      |

**LEGEND**

WR1 - Composite of subsamples WR1, 2, 3, and 4.

BACKGROUND - From the Poorman/Emma Mine (49-001-SS-1).

GW1 - Filled shaft.

GW2 - Duplicate of the sample 49-001-GW-1.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>Yager/Daisy</u>                    | County: <u>Sweetgrass</u>                  |
| Legal Description: T <u>7S</u> R <u>12E</u>           | Section(s): <u>NE 1/4, SW 1/4, Sec. 15</u> |
| Mining District: <u>Independence</u>                  | Mine Type: <u>Hardrock/Au</u>              |
| Latitude: <u>N 45° 13' 17"</u>                        | Primary Drainage: <u>Boulder River</u>     |
| Longitude: <u>W 110° 13' 10"</u>                      | USGS Code: <u>10070002</u>                 |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Basin Creek</u>     |
| Quad: <u>Haystack Peak</u>                            | Date Investigated: <u>August 11, 1993</u>  |
| Inspectors: <u>Bullock, Belanger, Clark</u>           | P.A. # <u>49-002</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- The volume of tailings present on the site was estimated to be 1700 cubic yards. The tailings were not contained in any impoundment and were in contact with a wetlands area. The following elements were elevated at least three times background:  
Arsenic: 138 mg/kg  
Lead: 226 to 700 mg/kg  
Mercury: 1.91 to 31.9 mg/kg
- The volume of waste rock associated with this site was estimated to be 10,150 cubic yards. The following elements were elevated at least three times background:  
Arsenic: 59.1 mg/kg  
Copper: 160 to 168 mg/kg  
Lead: 389 to 2520 mg/kg  
Cadmium: 2.92J mg/kg  
Mercury: 0.644 to 23.5 mg/kg
- Four discharging adits were present on site. GW-1 was flowing at approximately 15 gpm, had a pH of 6.85, and a specific conductance of 110 umhos/cm. Water from this adit did not exceed MCL/MCLGs, but did exceed chronic aquatic life criteria for copper and lead. GW-2 had a flow of approximately 10 gpm, a pH of 7.28, a specific conductance of 70 umhos/cm, and exceeded acute and chronic aquatic life criteria for copper. GW-3 was flowing at approximately 5 gpm, had a pH of 6.99 and a specific conductance of 170 umhos/cm. The water from this adit exceeded the MCL/MCLG for nickel, the chronic aquatic life criteria for copper, nickel, and zinc, and acute aquatic life criteria for copper and zinc. GW-4 had a flow at approximately 6 gpm, a pH of 3.78, a specific conductance of 190 umhos/cm, and exceeded chronic aquatic life criteria for iron and lead.
- Basin Creek flowed past the south side of the site. Water in the creek did not exceed MCL/MCLGs, but did exceed the acute and chronic aquatic life criteria for copper. This exceedance was attributable to the site. No observed releases were documented in either the surface water or the sediments.
- One open shaft and several structures were classified as potentially hazardous.

**Yager/Daisy PA# 49-002**  
**AMRB HAZARDOUS MATERIALS INVENTORY**  
**INVESTIGATOR: PIONEER - BULLOCK**  
**INVESTIGATION DATE: 08/11/93**

**SOLID MATRIX ANALYSES**

| Metals in soils   |                | Results per dry weight basis             |                                    |  |                  |                  |                  |                                     |  |            |            |            |            |                 |
|---|----------------|--|------------------------------------|--|------------------|------------------|------------------|-------------------------------------|--|------------|------------|------------|------------|-----------------|
| FIELD ID  | As (mg/Kg)     | Ba (mg/Kg)                               | Cd (mg/Kg)                         | Co (mg/Kg)                                 | Cr (mg/Kg)       | Cu (mg/Kg)       | Fe (mg/Kg)       | Hg (mg/Kg)                          | Mn (mg/Kg)                                 | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CYANIDE (mg/Kg) |
| 49-002-SE-1   | 5.66           | 49.2 J                                   | 0.54 UJ                            | 5.8  | 17.7             | 58.8             | 12100            | 0.032 U                             | 205  | 12.2       | 50.5       | 6.44 UJ    | 49.3       | NR              |
| 49-002-SE-2   | 5.21 U         | 45.8 J                                   | 0.57 UJ                            | 9.28                                       | 17.7             | 61.6             | 13200            | 0.031 U                             | 307  | 16.6       | 109        | 6.78 UJ    | 82.8       | NR              |
| 49-002-TP-1   | 138            | 122 J                                    | 0.56 UJ                            | 2.73                                       | 6.13             | 95.4             | 29300            | 1.91                                | 24.8                                       | 6.87       | 700        | 6.72 UJ    | 82.2       | NR              |
| 49-002-TP-2   | 19.6           | 82.4 J                                   | 1.31 J                             | 7.82                                       | 8.82             | 65               | 25300            | 31.9                                | 99   | 12         | 226        | 5.76 UJ    | 64         | NR              |
| 49-002-WR-1   | 59.1           | 140 J                                    | 2.92 J                             | 31   | 9.42             | 168              | 56900            | 0.644                               | 627  | 24.5       | 2520       | 5.91 UJ    | 296        | NR              |
| 49-002-WR-2   | 30.8           | 155 J                                    | 0.88 J                             | 12.1                                       | 17.4             | 160              | 41400            | 23.5                                | 199  | 18.9       | 389        | 5.77 UJ    | 40.4       | NR              |
| BACKGROUND  | 16.3           | 78.3 J                                   | 0.68 J                             | 13.5                                       | 45.6             | 40.1             | 28500            | 0.064                               | 612  | 24         | 37.2       | 7.97 UJ    | 99         | NR              |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                |  |                                    |  |                  |                  |                  |                                     |  |            |            |            |            |                 |
| Acid/Base Accounting  |                |  |                                    |  |                  |                  |                  |                                     |  |            |            |            |            |                 |
| FIELD ID  | TOTAL SULFUR % | TOTAL SULFUR ACID BASE $\frac{1}{1000t}$ | NEUTRAL. POTENT. $\frac{1}{1000t}$ | SULFUR ACID BASE POTENT. $\frac{1}{1000t}$ | SULFATE SULFUR % | PYRITIC SULFUR % | ORGANIC SULFUR % | PYRITIC ACID BASE $\frac{1}{1000t}$ | SULFUR ACID BASE POTENT. $\frac{1}{1000t}$ |            |            |            |            |                 |
| 49-002-TP-1   | 0.60           | 18.7                                     | -1.05                              | -19.8                                      | <0.01            | 0.32             | 0.48             | 10.0                                | -11.0                                      |            |            |            |            |                 |
| 49-002-TP-2   | 2.34           | 73.1                                     | 1.83                               | -71.3                                      | 0.53             | 0.75             | 1.06             | 23.4                                | -21.6                                      |            |            |            |            |                 |
| 49-002-WR-1   | 3.59           | 112                                      | 0.86                               | -111                                       | <0.01            | 1.65             | 2.45             | 51.5                                | -50.7                                      |            |            |            |            |                 |
| 49-002-WR-2   | 2.51           | 78.4                                     | 0.07                               | -78.3                                      | 0.56             | 0.37             | 1.58             | 11.6                                | -11.5                                      |            |            |            |            |                 |

**WATER MATRIX ANALYSES**

| Metals in Water   |                        | Results in ug/L |         |                                     |         |      |        |        |        |        |        |        |        | HARDNESS CALC. Zn (mg CaCO <sub>3</sub> /L) |
|---|------------------------|-----------------|---------|-------------------------------------|---------|------|--------|--------|--------|--------|--------|--------|--------|---|
| FIELD ID  | As                     | Ba              | Cd      | Co                                  | Cr      | Cu   | Fe     | Hg     | Mn     | Ni     | Pb     | Sb     |        |   |
| 49-002-GW-1   | 1.18 U                 | 37.5            | 2.57 U  | 9.7 U                               | 6.83 U  | 5.37 | 112    | 0.12 U | 4.08 U | 12.7 U | 1.33 J | 30.7 U | 10.1   | 30.8  |
| 49-002-GW-2   | 1.18 U                 | 33              | 2.57 U  | 9.7 U                               | 6.83 U  | 8.13 | 11.8 U | 0.12 U | 4.08 U | 12.7 U | 0.72 U | 30.7 U | 7.57 U | 18.1  |
| 49-002-GW-3   | 1.18 U                 | 32.9            | 2.57 U  | 9.7 U                               | 14.7    | 186  | 155    | 0.12 U | 9.17   | 115    | 1.22 J | 30.7 U | 171    | 51.2  |
| 49-002-GW-4   | 1.18 U                 | 26.3            | 2.57 U  | 9.7 U                               | 6.83 U  | 3.07 | 1500   | 0.12 U | 92.5   | 12.7 U | 9.37 J | 30.7 U | 20.5   | 23.9  |
| 49-002-SW-1   | 1.18 U                 | 24.3            | 2.57 U  | 9.7 U                               | 6.83 U  | 4.53 | 137    | 0.12 U | 8.43   | 12.7 U | 1.05 J | 30.7 U | 12.4   | 14.6  |
| 49-002-SW-2   | 1.18 U                 | 14.5            | 2.57 U  | 9.7 U                               | 6.83 U  | 2.27 | 15.2   | 0.12 U | 4.08 U | 12.7 U | 0.75 J | 30.7 U | 10.3   | 19.7  |
| U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested |                        |                 |         |                                     |         |      |        |        |        |        |        |        |        |   |
| Wet Chemistry Results in mg/l   |                        |                 |         |                                     |         |      |        |        |        |        |        |        |        |   |
| FIELD I.D.  | TOTAL DISSOLVED SOLIDS | CHLORIDE        | SULFATE | NO <sub>3</sub> /NO <sub>2</sub> -N | CYANIDE |      |        |        |        |        |        |        |        |   |
| 49-002-GW-1   | 71                     | 8.0             | 22      | < 0.05                              | NR      |      |        |        |        |        |        |        |        |   |
| 49-002-GW-2   | 56                     | 8               | 9       | < 0.05                              | NR      |      |        |        |        |        |        |        |        |   |
| 49-002-GW-3   | 100                    | 7.0             | 46      | 0.06                                | NR      |      |        |        |        |        |        |        |        |   |
| 49-002-GW-4   | 72                     | < 5.0           | 37      | 0.05                                | NR      |      |        |        |        |        |        |        |        |   |
| 49-002-SW-1   | 45                     | 6               | 9       | < 0.05                              | NR      |      |        |        |        |        |        |        |        |   |
| 49-002-SW-2   | 56                     | 13              | 8       | < 0.05                              | NR      |      |        |        |        |        |        |        |        |   |

**LEGEND**

SE1 - In Basin Creek, downgradient from site.  
 SE2 - In Basin Creek, upgradient of site.  
 TP1 - Composite of subsamples TP1A-A, 1B-A, and 1C-A.  
 TP2 - Composite of subsamples TP1A-B, 1B-B, and 1C-B.  
 WR1 - Composite of subsamples WR1A, 1B, 2A, 2B, and 3.  
 WR2 - Composite of subsamples WR2C, 4A, 5A, 5B, 6A, and 6B.  
 BACKGROUND - From the Poor Man/Emma Mine (49-001-SB-1).

GW1 - Adit discharge above lower, waste rock dump 6A.  
 GW2 - Adit discharge above waste rock dump 5.  
 GW3 - Adit discharge above waste rock dump 4.  
 GW4 - Adit discharge above waste rock dump 2.  
 SW1 - Same as sample SE1.  
 SW2 - Same as sample SE2.

**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU  
HAZARDOUS MATERIALS INVENTORY  
SITE SUMMARY**

|   |  |
|---|--|
| Mine/Site Name: <u>NW SE S22</u>                      | County: <u>Sweetgrass</u>                  |
| Legal Description: T <u>7S</u> R <u>12E</u>           | Section(s): <u>NE 1/4, NW 1/4, Sec. 22</u> |
| Mining District: <u>Independence</u>                  | Mine Type: <u>Hardrock/Unknown</u>         |
| Latitude: <u>N 45° 13' 03"</u>                        | Primary Drainage: <u>Boulder River</u>     |
| Longitude: <u>W 110° 13' 08"</u>                      | USGS Code: <u>10070002</u>                 |
| Land Status: <u>Private/Public</u>                    | Secondary Drainage: <u>Basin Creek</u>     |
| Quad: <u>Haystack Peak</u>                            | Date Investigated: <u>August 11, 1993</u>  |
| Inspectors: <u>Bullock</u>                            | P.A. # <u>49-003</u>                       |
| Organization: <u>Pioneer Technical Services, Inc.</u> |  |

- There were no mill tailings associated with this site.
- The volume of waste rock associated with this site was estimated to be 65 cubic yards. The following elements were elevated at least three times background:

|                    |                      |
|--------------------|----------------------|
| Arsenic: 329 mg/kg | Cadmium: 4.05J mg/kg |
| Copper: 125 mg/kg  | Lead: 1660 mg/kg     |
| Zinc: 745 mg/kg.   |                      |
- No discharging adits, seeps or springs were observed at the site, however running water could be heard in the caved adit.
- Basin Creek was approximately 900 feet away from the base of the waste rock dumps.
- There was one open adit classified as potentially hazardous.



NW Section 22 PA# 49-003  
AMRB HAZARDOUS MATERIALS INVENTORY  
INVESTIGATOR: PIONEER - BULLOCK  
INVESTIGATION DATE: 08/11/93

**SOLID MATRIX ANALYSES**

Metals in soils  
Results per dry weight basis

| FIELD ID    | As<br>(mg/Kg) | Ba<br>(mg/Kg) | Cd<br>(mg/Kg) | Co<br>(mg/Kg) | Cr<br>(mg/Kg) | Cu<br>(mg/Kg) | Fe<br>(mg/Kg) | Hg<br>(mg/Kg) | Mn<br>(mg/Kg) | Ni<br>(mg/Kg) | Pb<br>(mg/Kg) | Sb<br>(mg/Kg) | Zn<br>(mg/Kg) | CYANIDE<br>(mg/Kg) |
|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| 49-003-WR-1 | 329           | 196 J         | 4.05 J        | 17            | 15.6          | 125           | 42900         | 0.125         | 1780          | 30.5          | 1660          | 5.54 J        | 745           | NR                 |
| BACKGROUND  | 16.3          | 78.3 J        | 0.68 J        | 13.5          | 45.6          | 40.1          | 28500         | 0.064         | 612           | 24            | 37.2          | 7.97 UJ       | 99            | NR                 |

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

| FIELD ID    | TOTAL<br>SULFUR<br>% | TOTAL<br>SULFUR<br>ACID BASE<br>t/1000t | NEUTRAL<br>POTENT.<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t | SULFATE<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>% | ORGANIC<br>SULFUR<br>% | PYRITIC<br>SULFUR<br>ACID BASE<br>t/1000t | SULFUR<br>ACID BASE<br>POTENT.<br>t/1000t |
|-------------|----------------------|---|-------------------------------|---|------------------------|------------------------|------------------------|---|---|
| 49-003-WR-1 | 1.05                 | 32.8                                    | 10.2                          | -22.6                                     | 0.24                   | 0.17                   | 0.64                   | 5.31                                      | 4.88                                      |

**LEGEND**

WR1 - Composite of subsamples WR1A and 2A.  
BACKGROUND - From the Poor Man/Emma Mine  
(49-001-SS-1).

## 6.0 REFERENCES

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- Pioneer, 1993a. Sampling and Analysis Plan for the Abandoned Mines Hazardous Materials Inventory, August 1993.
- Pioneer, 1993b. Quality Assurance Project Plan for the Abandoned Mines Hazardous Materials Inventory, June 1993.
- Pioneer, 1993c. Laboratory Analytical Protocol for the Abandoned Mines Hazardous Materials Inventory, June 1993.
- Pioneer, 1993d. Health and Safety Plan for the Abandoned Mines Hazardous Materials Inventory, May 1993.

## GLOSSARY

**Abandoned Mine; Abandoned Workings** - Excavations, either open, caved, or sealed, that are deserted and in which further mining is not intended.

**Acid Mine Water** - Mine water which contains sulfuric acid, mainly due to the oxidation of iron pyrite.

**Acidity** - Estimate of the capacity for a neutral water to neutralize caustic wastes without disturbing biological activities.

**Activator (flotation mill)** - A reagent that facilitates flotation of selected mineral species in a flotation cell.

**Acute Aquatic Life Criteria** - EPA's maximum acute toxicity concentrations for protection of aquatic life and its uses as established under Section 304(a)(1) of the Clean Water Act, as amended.

**Adit** - A horizontal or nearly horizontal passage driven in rock from the surface for the working or dewatering of a mine.

**AIMSS** - Abandoned and Inactive Mines Scoring System.

**Alkalinity** - Estimate of the capacity for a neutral water to neutralize acidic wastes without disturbing biological activities.

**Amalgamation** - The process by which mercury is alloyed with some other metal to produce an amalgam. Used at one time for the extraction of gold and silver from pulverized ores.

**Alluvium** - Sediments deposited on land by streams and rivers.

**Attribution** - To document an observed release of a hazardous substance(s) to the environment, the presence of the hazardous substance(s) must be attributable to a waste source at the site. For example, if an observed release to surface water can be established for copper, the concentration of copper in any waste source at the site must exist at greater than three times the background concentration of copper to establish attribution to the site.

**BLM** - United States Department of Interior, Bureau of Land Management.

**Ball Mill** - A rotating horizontal cylinder in which nonmetallic materials are ground using various types of grinding media such as quartz pebbles, porcelain balls, or steel balls.

**Barren Solution** - Leaching solution that has been chemically stripped of metal values. Typically, the barren solution is recharged with leaching agent and recycled.

**Benefication** - The processing of ores for the purpose of (1) regulating the size of a desired product, (2) removing unwanted constituents, and (3) improving the quality, purity, or assay grade of a desired product.

**Bore Hole** - An exploratory or prospecting hole made by drilling.

**CECRA** - The Comprehensive Environmental Cleanup and Responsibility Act.

**CERCLA** - Comprehensive Environmental Response, Compensation, and Liability Act of 1980, also known as Superfund: Amended in 1986 by the Superfund Amendments and Reauthorization Act (SARA).

**Claim** - An area of land claimed by an individual or corporation for the ultimate purpose of mineral extraction. The dimensions of a lode claim are 600 by 1,500 feet; for a placer claim, 600 by 1,320 feet.

**Chronic Aquatic Life Criteria** - EPA's maximum chronic toxicity concentrations for protection of aquatic life and its uses as established under Section 304(a)(1) of the Clean Water Act, as amended.

**Collar** - The term applied to the timbering or concrete around the mouth or top of a shaft. The junction of a mine shaft with the surface.

**Collector (flotation mill)** - A reagent that aids or facilitates the attraction of mineral particles to the froth in a flotation cell.

**Comminution** - To reduce solids to minute particles by crushing and grinding to liberate metals.

**Concentrate** - To separate metal or ore from the associated gangue or barren rock.

**Concentrate (mineral concentrate)**- Enriched ore after the removal of waste in a beneficiation mill.

**Concentrator** - Mill or plant in which ore is concentrated by removing unwanted constituents.

**Containment** - Engineered structures designed to prevent releases to groundwater, such as liners, covers, and run-on diversions.

**Country Rock** - General term applied to the rock surrounding and penetrated by mineralized veins; in a wider sense applied to the rocks invaded by and surrounding an igneous intrusion.

**Cribbing** - A method of timbering used primarily to rectify the removal of too great a percentage of the rock on the advance, and has the effect of replacing part of the rock.

**Crosscut** - (1) A passageway driven at right angles to the main entry to connect it with a parallel entry or air course. (2) A horizontal opening driven across the course of a vein or in general perpendicular to the direction of the main workings.

**Crusher** - A machine for crushing rock or other materials. Among the various types of crushers are the ball-mill, gyratory crusher, Hadsel mill, jaw crusher, rod mill, rolls, stamp mill, and tube mill.

**Cyanide** - A salt or ester of hydrocyanic acid. In aqueous solution, cyanide is used to dissolve metal from gangue material for later recovery.



**Cyclone** - A device for classification by centrifugal means of fine particles suspended in water, whereby the coarser grains collect and are discharged at the apex of the vessel, while the finer particles are eliminated with the bulk of the water at the discharge orifice.

**Depressant (flotation mill)** - A reagent that causes selected mineral species to sink in a flotation cell.

**Drift** - A horizontal passage underground. A drift follows the vein, as distinguished from a crosscut, which intersects it.

**Drainage Basin Code** - Code assigned to each discrete hydrologic unit by the U.S. Geologic Survey.

**DHES-SHWB** - Montana Department of Health and Environmental Sciences, Solid and Hazardous Waste Bureau.

**DHES-WQB** - Montana Department of Health and Environmental Sciences, Water Quality Bureau.

**DNRC** - Montana Department of Natural Resources and Conservation.

**DSL-AMRB** - Montana Department of State Lands, Abandoned Mine Reclamation Bureau.

**Dump** - A pile or heap of waste rock material or other non-ore refuse near a mine.

**Electrowinning** - Recovery of a metal from an ore or solution by electrochemical processes.

**EPA** - United States Environmental Protection Agency.

**Face** - The surface exposed by excavation. The working face, front, or forehead is the face at the end of the tunnel heading, or at the end of the full size excavation.

**Floodplain** - An alluvial plain caused by the overbank deposition of alluvial material. They typically appear as flat expanses of land bordering a stream or river. Most floodplains are accompanied by a series of alluvial terraces of varying levels.

**Fluvial** - pertaining to or produced by the action of a stream or river.

**Flotation** - The method of mineral separation in which a froth created in water by a variety of reagents floats some finely crushed minerals, whereas other mineral sink.

**Flotation Cell** - Device in which froth flotation of ores is performed. It has provisions for receiving conditioned pulp, aerating the pulp, and for separate discharge of the resulting mineralized froth and impoverished tailings.

**Frother** - A reagent which serves to stabilize the froth in a flotation cell until it can be scraped off into the concentrate launder.

**Glory Hole** - Large open hole typically associated with a mined-out or widened shaft.

**Gravity Mill** - A process in which heavy metals or minerals are separated from waste by the action of agitation and gravity on materials suspended in a liquid, usually water.

**Grizzly** - A device used for coarse screening of bulk materials. A rugged screen for rough sizing at a comparatively large size (for example, 6-inches); it can comprise fixed or moving bars, disks, or shaped tumblers or rollers.

**Hand Auger** - A large tool modeled after the carpenter's drill used in soil sampling.

**Hazardous Substance** - CERCLA hazardous substances, pollutants, and contaminants as defined in CERCLA Sections 101(14) and 101(33).

**Headframe** - The vertical steel or timber frame at the top of a shaft, which carries the sheave or pulley for the hoist.

**Heavy Metal** - Principally the metals zinc, copper, cobalt, and lead; however, may include one or more of the following metals: bismuth, cadmium, gold, indium, iron, manganese, mercury, nickel, palladium, silver, thallium, and tin (often included, though not a metal).

**Highwall** - The unexcavated face of exposed overburden and coal or ore in an open-cast mine or the face or bank on the uphill side of a contour strip mine excavation.

**Hoist** - (1) A drum on which wire rope is wound in the engine house, as the cage or skip is raised in the hoisting shaft. (2) An engine with a drum used for winding up a load from a shaft.

**HRS** - EPA's Hazard Ranking System (Federal Register, Vol. 55, No. 241, pp 51532 -51667).

**Inclined Shaft or Incline** - A non-vertical shaft; usually along the dip of a vein.

**Intermittent Stream** - A stream or stretch of stream which flows only at certain times of the year when it receives water from springs, snow melt or storm runoff.

**Jaw Crusher** - A primary crusher designed to reduce large rocks or ores to sizes capable of being handled by a secondary crusher. It consists of a moving jaw, hinged at one end, which swings toward and away from a stationary jaw in a regular oscillatory cycle.

**Jig (Mineral Jig)** - A machine in which the feed is stratified in water by means of a pulsating motion and from which the stratified products are separately removed, the pulsating motion usually being obtained by alternate upward and downward currents of water.

**Latitude** - The angular distance north or south from the equator of a point on the earth's surface, expressed in degrees.

**Leaching** - (1) The removal in solution of the more soluble minerals by percolating waters. (2) Extracting a soluble metallic compound from an ore by selectively dissolving it in a suitable solvent, such as water, sulfuric acid, hydrochloric acid, cyanide, etc.

**Legal Description** - The Township, Range, Section, and typically quarter/quarter section location.

**Level** - A main underground roadway or passage driven along the level course to afford access to the stopes or workings and to provide ventilation and haulageways for the removal of ore.

**Loadout** - A receptacle for ore awaiting treatment or shipment, also referred to as an ore bin.

**Longitude** - an angular distance east or west from the meridian of some particular place to the prime meridian at Greenwich, England.

**MCL** - Maximum contaminant level: Established under the Safe Drinking Water Act.

**MCLG** - Maximum contaminant level goal: Established under the Safe Drinking Water Act.

**MBMG** - Montana Bureau of Mines and Geology.

**Master Inventory** - Inventory of all identifiable abandoned or inactive hardrock mine sites in Montana conducted by the DSL-AMRB.

**Mesh** - The number of openings per unit area of a screen (sieve).

**Mill** - A mineral treatment plant in which crushing, grinding, and further processing of ore is conducted to produce a product.

**Milling** - The processing of ore to produce a product.

**Mine** - Excavation of earth for the extraction of ore or other economic minerals.

**Mine Development** - The term used to describe the operations involved in preparing a mine for ore extraction. These operations may include tunneling, sinking, crosscutting, drifting, and raising.

**Mineral** - An inorganic substance occurring in nature, though not necessarily of inorganic origin, which has (1) a definite chemical composition or, more commonly, a characteristic range of composition, and (2) distinctive physical properties or molecular structure.

**Mineral Dressing** - Physical and chemical concentration of raw ore into a product from which a metal can be recovered for a profit.

**Mineral Deposit** - A surface or underground body of mineral matter that may be utilized for its industrial mineral or metal content.

**Observed Release** - Concentration of hazardous substance(s) has increased significantly (greater than three times) above the background concentration for the site for that specific type of sample. For example, to document an observed release to surface water, a contaminant concentration detected in a surface water sample collected downstream from a site must exceed the concentration detected in a surface water sample collected upstream from the site by more than three times. See also "Attribution".

**ABANDONED AND INACTIVE MINES  
SCORING SYSTEM (AIMSS)  
FOR THE  
ABANDONED MINES  
HAZARDOUS MATERIALS INVENTORY**

**Abandoned Mine Reclamation Bureau  
Montana Department of State Lands  
1625 11th Avenue  
Helena, Montana 59620**

**MARCH 1994**





**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINES AND RECLAMATION BUREAU**

**ABANDONED HARDROCK MINE PRIORITY SITES  
ABANDONED AND INACTIVE MINES SCORING SYSTEM  
(AIMSS)**

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**APPENDIX A - ABBREVIATED AIMSS SCORING INSTRUCTIONS AND FORM**  
**APPENDIX B - WASTE CHARACTERISTICS WORKSHEET**



## 1.0 INTRODUCTION

This document describes the Abandoned and Inactive Mines Scoring System (AIMSS) used by the MDL/AMRB to prioritize abandoned and inactive mining sites and to allocate resources. The scoring system is modelled after the USEPA's Hazard Ranking System (Federal Register, 1990); however, it has been modified to specifically address mining sites in Montana. Many of the evaluation factors and scores are similar to and were derived from the HRS; the scoring algorithm is identical to that used in the HRS. The philosophy and basis for many of the assumptions and evaluations are described in great detail in the documentation for the HRS and are not reiterated here. Any substantive changes to the HRS scoring to accommodate the AIMSS are identified and discussed. The primary source of information used to score mine sites were the site visits performed during 1993, and the laboratory data and inventory forms generated by those investigations.

Standard criteria were developed by MDL/AMRB, based primarily on criteria in EPA's HRS, for determining priorities among releases or threatened releases of hazardous substances from abandoned and inactive mines throughout the State of Montana, for the purpose of taking remedial action and determining the urgency for such action. These criteria and priorities are based on the relative risk to public health or the environment, taking into account the population at risk, the hazard potential of the substances, the potential for contamination of drinking water supplies, the potential for direct human contact, and the potential for detrimental effects to sensitive ecosystems.

Site-specific criteria for evaluation include:

- The extent of actual releases, and the potential to release hazardous constituents from the site into the environment;
- The quantity, toxicity, and concentrations of hazardous constituents in waste materials at the site; and,
- The degree of risk to human health and the environment posed by those hazardous constituents.

The AIMSS is not, and is not intended to be, equivalent to a detailed qualitative or quantitative risk assessment, as might be performed as part of remedial actions. This scoring is used to rank differing and disparate sites, as accurately as is feasible with existing or easily obtainable information, using a common basis - relative risks to human health or the environment. The data requirements for the AIMSS do not include long-term monitoring or an accurate determination of the full nature and extent of contamination at a site, nor the projected levels of exposure. The AIMSS attempts to estimate risks posed by each site being evaluated relative to the other mine sites evaluated. Since the scoring is intended only as a preliminary screening/prioritization mechanism, the effects of potential inaccuracies have been minimized by intervalizing



those data with the greatest degree of uncertainty (e.g. population and waste quantities). It also maximizes the use of existing site data: the measured concentrations of constituents present in waste materials with respect to background concentrations; and, actual releases of hazardous constituents to the environment.

The scoring system's structure (algorithm) is identical to that used by the EPA HRS. Four pathways or routes of exposure are evaluated:

- The groundwater pathway,
- The surface water pathway,
- The air pathway, and
- The direct contact pathway (soil exposure pathway in the HRS).

The four separate pathway scores are summed directly (not the sum of squares used in the HRS) and divided by a constant. Using the sum of squares method for combining the four pathway scores effectively equalizes each of the pathways in terms of relative risk. This would have an undesirable effect on the scoring, given the greater relative importance of the water pathways, and the relatively limited data for the air pathway.

Within each of the four pathways, three primary factors are evaluated:

- The likelihood of release, including observed releases of site hazardous constituents to the pathway and the potential to release to the pathway;
- Waste characteristics, including the concentrations of hazardous constituents corrected for background, the quantity of wastes (volumes, areas), and the relative toxicity of each constituent to humans and ecosystems; and,
- The potential receptors (targets) of exposure to hazardous constituents at the site, both human and environmental.

The three primary factors are multiplied together (as in the EPA HRS) to derive each of the four pathway scores. This equalizes the relative effect of each primary factor in terms of changing the overall pathway score. Hence, a greater likelihood of release, higher constituent concentrations, or more potential receptors all affect the pathway score similarly, as is necessary and proper for an evaluation of relative risk.

The following is a discussion of the each of the pathways, factors, and other site-specific criteria as they relate to the AIMSS. Several factors are redundant between pathways; these factors will be fully discussed the first time they are identified, and referenced when used subsequently. Again, wherever possible, factors and scores are similar to those used in the EPA HRS. A primary source of data is the AMRB Hazardous Materials Inventory Form filled out for each site.

## 2.0 GROUNDWATER PATHWAY

The groundwater pathway is evaluated using three factors: the likelihood of release to groundwater, groundwater waste characteristics, and groundwater targets. The product of these three factors is the groundwater pathway score.

### 2.1 GROUNDWATER LIKELIHOOD OF RELEASE

The likelihood of release factor evaluates three subfactors for scoring: observed releases to groundwater, exceedances of drinking water standards, and potential to release.

#### 2.1.1 Observed Release

An observed release to groundwater is defined as a downgradient groundwater concentration at more than three times the upgradient groundwater concentration, for any constituent that can be attributed to the site (same as EPA HRS). Groundwater concentrations used for this evaluation can be measured in monitoring wells, domestic wells, or seeps/springs, and concentrations do not have to exceed any standards to score an observed release. A constituent is considered attributable to the site if that constituent exists in any waste material at the site at a concentration that is more than three times the background concentration of the constituent. Discharging adits are not considered observed releases; they are considered sources and are evaluated later in the waste characteristics section. An observed release to groundwater, that can be documented using the above criteria, is assigned a score of 300, otherwise this score is 0.

#### 2.1.2 Exceedances

A downgradient groundwater concentration in a domestic well or monitoring well that exceeds USEPA MCL's or MCLG's for any constituent that can be attributed to the site, is assigned a score of 100, whether or not an observed release to groundwater is documented. Current USEPA MCL's and MCLG's used for this evaluation are listed below:

|         |           |          |            |         |         |
|---------|-----------|----------|------------|---------|---------|
| Arsenic | 50 ug/L   | Barium   | 2,000 ug/L | Cadmium | 5 ug/L  |
| Copper  | 1300 ug/L | Chromium | 100 ug/L   | Mercury | 2 ug/L  |
| Nickel  | 100 ug/L  | Antimony | 6 ug/L     | Lead    | 15 ug/L |
| Cyanide | 200 ug/L  |          |            |         |         |

#### 2.1.3 Potential to Release

The potential to release constituents to groundwater is evaluated using two criteria: the containment of the wastes at the site; and, the estimated depth to groundwater.

### 2.1.3.1 Containment

Containment is evaluated with respect to engineered structures designed to prevent releases to groundwater, such as liners, covers, and runoff diversions. These engineered structures must be intact, functioning, and regularly monitored/maintained. Using the least contained waste material at the site, assign a value as follows: no containment = 20; presence of either a liner, runoff diversions, or a vegetated topsoil cover = 10; presence of two of the above three structures = 5; and, completely contained (all of the above) = 1.

### 2.1.3.2 Depth to groundwater

The depth to groundwater is estimated using the existing well logs from the area, observation of springs, seeps or flowing adits at the site, and the relative topography of the site (stream valley or hilltop). Using this estimated depth (or actual depth, if available), assign a value as follows: shallow (less than 25 feet to water) = 20; moderate (25 to 100 feet) = 10; or, deep (greater than 100 feet) = 2.

### 2.1.3.3 Potential to release score

Calculate the potential to release score by multiplying the containment value by the depth value (Maximum score is 400).

### 2.1.4 Groundwater Likelihood of Release Score

The groundwater likelihood of release score is the sum of the observed release, exceedances, and potential to release scores (Maximum = 800). Using the sum of the three subfactor scores differs from the EPA HRS in that the HRS uses the higher of the observed release or the potential to release scores, while exceedances are evaluated under the targets score. The scoring strategy used here accounts for both the observed release to the pathway and the potential to continue releasing constituents to the pathway. Exceedances are included to account for the magnitude (concentration) of constituents actually found in the pathway.

## 2.2 GROUNDWATER WASTE CHARACTERISTICS

Waste characteristics for the groundwater pathway are evaluated using the volume of waste materials (sources) at the site, the concentrations of constituents in samples of the waste material, the background concentrations, and the EPA HRS human toxicity value (SCDM, 1993).

### 2.2.1 Quantity

A quantity value is assigned according to measured volumes of waste materials in cubic yards (cy) for each solid matrix source(s) or portions of a source, for which



analytical data exist. Each sample collected at a site is assigned a volume that the sample represents (sample volume assignments are tabulated on the waste characteristics worksheet). This sample volume was derived based on the source volume(s) that the composite sample analyses represents (see SOP regarding XRF analyses and sample compositing; see also the AMRB Sampling and Analysis Plan, Pioneer, 1993).

Also, a value is assigned for each measured and sampled adit discharge in gallons per day (gpd = cubic feet per second X 646,272 gpd/cfs). The conversion of cfs to gpd is used to equate adit discharges (highly mobile constituents) with other solid matrix sources (less mobile) at the site.

This approach differs significantly from the HRS waste characteristics score calculation. First, adit discharges are not considered sources in the HRS. Second, the HRS only considers the most toxic constituent found at the site, does not consider the concentration, and applies the most toxic constituent to the entire volume of wastes at the site. The AIMSS scoring method more fairly evaluates relative risks between sites, accounting for site specific constituent concentrations, the varying toxicity of different constituents, and includes adit discharges in the source evaluation. This method more accurately discriminates between sites with higher concentrations or more toxic constituents in relation to sites with lower concentrations or less toxic constituents. However, it is also more difficult to calculate.

Each media (solid or water) and sampled source at the site will be scored separately. Assign the sample quantity value and the toxicity value as follows:

| <u>Range<br/>(cy or gpd)</u> | <u>Quantity<br/>Value</u> | <u>Constituent</u> | <u>Human<br/>Toxicity Value</u> |
|------------------------------|---------------------------|--------------------|---------------------------------|
| less than 10                 | 0.003                     | Antimony           | 10.                             |
| 10-30                        | 0.01                      | Arsenic            | 10.                             |
| 30-100                       | 0.03                      | Barium             | 0.01                            |
| 100-300                      | 0.1                       | Cadmium            | 10.                             |
| 300-1,000                    | 0.3                       | Chromium           | 10.                             |
| 1,000-3,000                  | 1.                        | Copper             | 0.                              |
| 3,000-10,000                 | 3.                        | Iron               | 0.                              |
| 10,000-30,000                | 10.                       | Lead               | 10.                             |
| 30,000-100,000               | 30.                       | Mercury            | 10.                             |
| 100,000-300,000              | 100.                      | Nickel             | 10.                             |
| 300,000-1,000,000            | 300.                      | Zinc               | 0.01                            |
| more than 1,000,000          | 1,000.                    | Thorium            | 10.                             |
|                              |                           | Uranium            | 10.                             |
|                              |                           | Cyanide            | 0.1                             |
|                              |                           | Asbestos           | 10.                             |



### 2.2.2 Hazard

Calculated for each constituent (note: asbestos is not included in the groundwater waste characteristics evaluation since it is immobile in groundwater) as the product of the sample concentration (solids in mg/Kg or water in ug/L) and toxicity values (derived from the EPA HRS human toxicity values divided by 1,000; SCDM, 1993). Solid sample concentrations are corrected by subtracting background concentrations, and using the difference in the calculation; adit discharge concentrations are used directly because background concentrations are not applicable.

Manganese was excluded from the calculation of all hazard values. Mn is generally present at every mining site at concentrations between 2 and 3 orders of magnitude higher than other constituents, even after correcting for background. Mn is assigned a toxicity value of 10, according to HRS, due to high toxicity in metallic form; Mn-oxides, the form that Mn occurs in at mining sites, are much less toxic. When calculating hazard values, these two criteria combine to give manganese concentrations an unintended influence over the total hazard score. This is in spite of the fact that there are no MCL's or AWQC for manganese. For these reasons, and in the interest of accurately evaluating relative risks at mining sites, manganese is excluded from the waste characteristics calculations, for both solid and aqueous sources.

A separate product is calculated for each element and the element-products are summed for each sample.

For sample #1:

Constituent 1: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

Constituent 2: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

Constituent n: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

The sum of the element-products is the hazard value for sample #1 = \_\_\_\_\_

The hazard value procedure is repeated for each sample collected at the site.

For sample #n:

Constituent 1: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

Constituent n: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

Sum of element-products (hazard value) for sample #n = \_\_\_\_\_

### 2.2.3 Groundwater Waste Characteristics Score

The waste characteristics score is calculated by multiplying the sample quantity value (Appendix B) and the hazard value (calculated above) for each sample, summing the values for all samples, and then dividing by 10,000:

Sample #1: Sample quantity value x sample #1 hazard value = \_\_\_\_\_

Sample #n: Sample quantity value x sample #n hazard value = \_\_\_\_\_

The groundwater waste characteristics score is the sum of the sample products divided by 10,000.

### 2.3 GROUNDWATER TARGETS

The groundwater targets score is evaluated by assessing those potential users of groundwater, giving a greater weight to those potential groundwater users that are closer to the site. This method differs slightly from the HRS in that the detailed wells/distance/dilution factoring is simplified reflecting the limited well information available.

#### 2.3.1 Number of Wells Within 1 Mile

This value is derived using the number of wells within 1 mile of the site, as reported in the MBMG well inventory database, multiplied by 2.5 persons per well. The assumption of 2.5 persons per well is based on the average persons per residence reported for Montana.

#### 2.3.2 Number of Wells Between 1 and 4 Miles

This value is derived using the number of wells within 4 miles of the site, as reported in the MBMG well inventory database, and subtracting the number of wells within 1 mile (above). These targets are also multiplied by 2.5 persons per well, and then divided by a distance/dilution factor of 2.5, to reflect the lessened risk due to greater distance from the sources and dilution.

#### 2.3.3 Distance to Nearest Well

This value is an adjustment used to emphasize the greater risk to wells close to the site (per HRS). Only the nearest well is used (residential or recreational use), regardless of the number or frequency of persons using that well. Assign a value as follows: less than 1000 feet = 10; between 1000 feet and 1/2 mile = 5; and, more than 1/2 mile or unknown = 0.

#### 2.3.4 Groundwater Targets Score

The groundwater targets score is the sum of the above three values: wells within 1 mile, wells between 1 and 4 miles, and the nearest well value.

## **2.4 GROUNDWATER PATHWAY SCORE**

The Groundwater Pathway Score is the product of the Groundwater Likelihood of Release Score (section 2.1), the Groundwater Waste Characteristics Score (section 2.2), and the Groundwater Targets Score (section 2.3).

## **3.0 SURFACE WATER PATHWAY**

The surface water pathway is evaluated using three factors: the likelihood of release to surface water, surface water waste characteristics, and surface water targets. The product of these three factors is the surface water pathway score.

### **3.1 SURFACE WATER LIKELIHOOD OF RELEASE**

The likelihood of release factor evaluates three subfactors for scoring: observed releases to surface water, exceedances of drinking water or ambient water quality standards, and potential to release.

#### **3.1.1 Observed Release**

An observed release to surface water is defined as a downstream surface water or stream sediment concentration at more than three times the upstream surface water or sediment concentration, for any constituent that can be attributed to the site (same as EPA HRS). Surface water or sediment concentrations used for this evaluation can be measured in perennial or intermittent surface water drainages, and concentrations do not have to exceed any standards to score an observed release. A constituent is considered attributable to the site if that constituent exists in any waste material at the site at a concentration more than three times the background concentration of the constituent. Discharging adits are not considered observed releases; they are considered sources and are evaluated later in the waste characteristics section. An observed release to surface water, that can be documented using the above criteria, is assigned a score of 300, otherwise this score is 0.

#### **3.1.2 Exceedances**

A downstream surface water concentration that exceeds USEPA MCL's or MCLG's for a constituent that can be attributed to the site, is assigned a score of 100, whether or not an observed release to surface water can be documented. A downstream surface water concentration exceeding USEPA or State acute Ambient Water Quality Criteria (AWQC), but not MCL's, for a constituent that can be attributed to the site, is assigned a score of 50 (do not add 50 if MCL's are also exceeded).



Current USEPA MCL's and MCLG's used for this evaluation are listed below:

|         |           |          |            |         |         |
|---------|-----------|----------|------------|---------|---------|
| Arsenic | 50 ug/L   | Barium   | 2,000 ug/L | Cadmium | 5 ug/L  |
| Copper  | 1300 ug/L | Chromium | 100 ug/L   | Mercury | 2 ug/L  |
| Nickel  | 100 ug/L  | Antimony | 6 ug/L     | Lead    | 15 ug/L |
| Cyanide | 200 ug/L  |          |            |         |         |

Current State of Montana acute AWQC used for this evaluation are listed below (note that most criteria are a complex exponential function of hardness):

|          |   |
|----------|---|
| Arsenic  | 360 ug/L  |
| Cadmium  | $\exp((1.128 \times \ln(\text{hardness})) - 3.828)$   |
| Copper   | $\exp((0.9422 \times \ln(\text{hardness})) - 1.464)$  |
| Chromium | $\exp((0.819 \times \ln(\text{hardness})) + 3.688)$   |
| Mercury  | 2.4 ug/L  |
| Nickel   | $\exp((0.846 \times \ln(\text{hardness})) + 3.3612)$  |
| Lead     | $\exp((1.273 \times \ln(\text{hardness})) - 1.46)$    |
| Zinc     | $\exp((0.8473 \times \ln(\text{hardness})) + 0.8604)$ |

### 3.1.3 Potential to Release

The potential to release constituents to surface water is evaluated using two criteria: the containment of the wastes at the site; and, the distance from waste materials to surface water.

#### 3.1.3.1 Containment

Containment is evaluated with respect to engineered structures designed to mitigate releases to surface water (via flooding and storm runoff) including dams, diversions, sediment basins, or other intact, functioning engineered system. Using the least contained waste material at the site, assign a value as follows: no functioning containment structures = 20; presence of one of the containment structures listed above = 10; wastes completely contained with respect to surface water = 1.

#### 3.1.3.2 Distance to surface water

The shortest distance from any waste material to the nearest surface water drainage (including intermittent drainages) was recorded on the AMRB inventory form during the site visit. Use this distance to assign a value as follows: less than 25 feet = 20; between 25 and 100 feet = 10; and, greater than 100 feet = 2.

#### 3.1.3.3 Potential to release score

Calculate the potential to release score by multiplying the containment value by the distance value (Maximum score = 400).



### 3.1.4 Surface Water Likelihood of Release Score

The surface water likelihood of release score is the sum of the observed release, exceedances, and potential to release scores (Maximum = 800). Using the sum of the three subfactor scores differs from the EPA HRS in that the HRS uses the higher of the observed release or the potential to release scores, while exceedances are evaluated under the targets score. The scoring strategy used here accounts for both the observed release to the pathway and the potential to continue releasing constituents to the pathway. Exceedances are included to account for the magnitude (concentration) of constituents actually found in the pathway.

## 3.2 SURFACE WATER WASTE CHARACTERISTICS

Waste characteristics for the surface water pathway are evaluated using the volume of waste materials at the site, the concentrations of constituents in samples of the waste material, the background concentrations, and the EPA HRS human toxicity and ecotoxicity values (SCDM, 1993).

### 3.2.1 Quantity

A quantity value is assigned in the same manner as the groundwater pathway (section 2.2.1). A value is also assigned for adit discharges as in the groundwater pathway.

Each media (solid or water) and sampled source at the site will be scored separately. Assign the sample quantity value, the toxicity value, and the ecotoxicity value as follows:

| <u>Range</u><br><u>(cy or gpd)</u> | <u>Quantity</u><br><u>Value</u> | <u>Constituent</u> | <u>Human</u><br><u>Toxicity Value</u> | <u>Ecotoxicity</u><br><u>Value</u> |
|------------------------------------|---------------------------------|--------------------|---------------------------------------|------------------------------------|
| less than 10                       | 0.003                           | Antimony           | 10.                                   | 0.                                 |
| 10-30                              | 0.01                            | Arsenic            | 10.                                   | 0.01                               |
| 30-100                             | 0.03                            | Barium             | 0.01                                  | 0.001                              |
| 100-300                            | 0.1                             | Cadmium            | 10.                                   | 1.                                 |
| 300-1,000                          | 0.3                             | Chromium           | 10.                                   | 0.1                                |
| 1,000-3,000                        | 1.                              | Copper             | 0.                                    | 0.1                                |
| 3,000-10,000                       | 3.                              | Iron               | 0.                                    | 0.01                               |
| 10,000-30,000                      | 10.                             | Lead               | 10.                                   | 1.                                 |
| 30,000-100,000                     | 30.                             | Mercury            | 10.                                   | 10.                                |
| 100,000-300,000                    | 100.                            | Nickel             | 10.                                   | 0.01                               |
| 300,000-1,000,000                  | 300.                            | Zinc               | 0.01                                  | 0.01                               |
| more than 1,000,000                | 1,000.                          | Thorium            | 10.                                   | 10.                                |
|                                    |                                 | Uranium            | 10.                                   | 10.                                |
|                                    |                                 | Cyanide            | 0.1                                   | 1.                                 |
|                                    |                                 | Asbestos           | 10.                                   | 0.                                 |

Calculated for each constituent (note: manganese is excluded, asbestos is included) as the product of the sample concentration (corrected by subtracting out background, solids in mg/Kg or water in ug/L) and human toxicity values (derived from the EPA HRS human toxicity values/1,000; SCDM. 1993). A separate product is calculated for each element and the element-products are summed for each sample.

For sample #1:

Constituent 1: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

Constituent 2: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

Constituent n: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

The sum of the element-products is the human hazard value for sample #1 = \_\_\_\_\_

The human hazard value procedure is repeated for each sample collected at the site.

For sample #n:

Constituent 1: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

Constituent n: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

Sum of element-products (human hazard value) for sample #n = \_\_\_\_\_

The waste score (human) is calculated by multiplying the sample quantity value (Appendix B) and the human hazard value (calculated above) for each sample, summing the values for all samples, and then dividing by 10,000:

Sample #1: Sample quantity value x sample #1 human hazard value = \_\_\_\_\_

Sample #n: Sample quantity value x sample #n human hazard value = \_\_\_\_\_

The waste score (human) is the sum of the sample products divided by 10,000.

### 3.2.3 Ecological Hazard

Calculated for each constituent (note manganese is excluded) as the product of the sample concentration (corrected by subtracting out background, solids in mg/Kg or water in ug/L) and ecotoxicity values (derived from the EPA HRS ecotoxicity values/1,000; SCDM, 1993, see table in section 3.2.1). A separate product is calculated for each element and the element-products are summed for each sample.

For sample #1:

Constituent 1: (Sample conc. - background conc.) x ecotoxicity value = \_\_\_\_\_

Constituent 2: (Sample conc. - background conc.) x ecotoxicity value = \_\_\_\_\_

Constituent n: (Sample conc. - background conc.) x ecotoxicity value = \_\_\_\_\_

The sum of element-products is the ecohazard value for sample #1 = \_\_\_\_\_

The ecohazard value procedure is repeated for each sample collected at the site.

For sample #n:

Constituent 1: (Sample conc. - background conc.) x ecotoxicity value = \_\_\_\_\_

Constituent n: (Sample conc. - background conc.) x ecotoxicity value = \_\_\_\_\_

Sum of element-products (ecohazard value) for sample #n = \_\_\_\_\_

The waste score (ecologic) is calculated by multiplying the sample quantity value (Appendix B) and the ecohazard value (calculated above) for each sample, summing the values for all samples, and then dividing by 10,000:

Sample #1: Sample quantity value x sample #1 ecohazard value = \_\_\_\_\_

Sample #n: Sample quantity value x sample #n ecohazard value = \_\_\_\_\_

The waste score (ecologic) is the sum of the sample products divided by 10,000.

### 3.2.4 Surface Water Waste Characteristics Score

The total surface water waste characteristics score is the sum the waste score (human) and the waste score (ecologic).

## 3.3 SURFACE WATER TARGETS

The surface water targets score is evaluated by assessing those potential users of surface water within 15 miles downstream (same as HRS target distance limit), including environmental targets (wetlands, fisheries, etc.). The target scoring differs from the HRS in that it is simplified and includes a target that the HRS does not consider (impacted drainages).

### 3.3.1 Number of Persons Using Surface Water for Drinking Water

The number of persons using surface water for drinking water was compiled from Water Quality Bureau records regarding stream designations for drinking water supplies and



inventoried water systems. The total population served was adjusted for dilution of the receiving stream, per the HRS dilution factors. The potentially affected drinking water intakes that were used for sites evaluated in this assessment, and the appropriate dilution factors are listed below.

| <u>Water System - Location</u>    | <u>Service Population</u> | <u>Flow</u> | <u>Dilution Factor*</u> | <u>Adjusted Population</u> |
|-----------------------------------|---------------------------|-------------|-------------------------|----------------------------|
| Helena - Tenmile Creek intake     | 24,500                    | 17 cfs      | 0.1                     | 2,450                      |
| Butte - Basin Creek / Big Hole R. | 33,744                    | 19 cfs      | 0.1                     | 3,374                      |
| Anaconda - Silver Lake pipeline   | 9,771                     | 21 cfs      | 0.1                     | 977                        |

\* The HRS dilution factor for receiving streams between 10 and 100 cfs = 0.1.

### 3.3.2 Impacted Drainage(s)

The distance of impacted stream/drainage downstream from the site with respect to sedimentation and acid mine drainage characteristics was recorded on the inventory form during the site visit. The value assigned is the distance in thousands of feet (observed impacted distance / 1,000).

### 3.3.3 Other Surface Water Uses

Other surface water resource use within 15 miles downstream were determined from the site visit, inspection of the MDFWP data base (fisheries, wetlands, threatened and endangered species), USGS topographic maps and USDA Forest Service maps, and the MDNRC water rights database. Assign these values as follows:

Wetlands (5 acre minimum) observed or in MDFWP database = 10; otherwise = 0.

Fishery class in MDFWP database: Class 1 = 20; Class 2 = 10; Class 3 = 5;  
Class 4 = 1; Class 5, Class 6, or not classified = 0.

Recreational use at downstream parks or recreation areas (maps, observation) = 5; otherwise = 0.

Irrigation / Stock watering from MDNRC database, observed at site, or on maps = 2; else = 0.

Threatened/Endangered Species Habitat from MDFWP database = 5; otherwise = 0.

### 3.3.4 Surface Water Targets Score

The surface water targets score is the sum of the above seven values: drinking water use, impacted drainages, wetlands, fishery, recreation use, irrigation/stock watering, and threatened/endangered species habitat.



### 3.4 SURFACE WATER PATHWAY SCORE

The Surface Water Pathway score is the product of the Surface Water Likelihood of Release Score (section 3.1), the Surface Water Waste Characteristics Score (section 3.2), and the Surface Water Targets Score (section 3.3).

## 4.0 AIR PATHWAY

The air pathway is evaluated using three factors: the likelihood of release to the atmosphere, air waste characteristics, and air targets. The product of these three factors is the air pathway score.

### 4.1 AIR LIKELIHOOD OF RELEASE

The likelihood of release factor evaluates two subfactors for scoring: observed release to the air pathway and the potential to release to the air pathway.

#### 4.1.1 Observed Release

An observed release to the air pathway is defined in three ways: materials that were observed blowing off the site during the site inspection (e.g. dust); evidence of wind deposited wastes was observed away from the waste sources (e.g. dunes); or, anecdotal evidence from other investigators, local residents, or other reliable sources. One or more constituents in the source must be at a concentration more than three times the background concentration. A score of 200 is assigned for an observed release to the air pathway meeting the above criteria, otherwise score 0.

#### 4.1.2 Potential to Release

The potential to release constituents to the air pathway is evaluated using two criteria: the containment of the wastes at the site; and, the distance to the nearest population.

##### 4.1.2.1 Containment

Containment is evaluated with respect to dust emissions (topsoil, vegetative cover, or perennially wet). Dust propagation potential was evaluated during the site visit and is recorded on the inventory form as high, moderate, low, or none. The dust potential was derived considering the percent of vegetative or other cover, available fines, topography, and moisture content. Using the highest dust propagation potential noted on the form, assign a value as follows: high dust potential = 20; moderate dust potential = 15; low dust potential = 10; no dust potential = 1.

#### 4.1.2.2 Distance to nearest population

The shortest distance from any waste material to the nearest population (town) or individual residence was recorded on the AMRB inventory form during the site visit. Use this distance to assign a value as follows: less than 1,000 feet = 20; between 1,000 feet and 1/2 mile = 10; and, greater than 1/2 mile = 5.

#### 4.1.2.3 Potential to release score

Calculate the potential to release score by multiplying the containment value by the distance value (Maximum score = 400).

#### 4.1.3 Air Likelihood of Release Score

The Air Likelihood of Release Score is the sum of the observed release and potential to release scores (Maximum score = 600).

### 4.2 AIR WASTE CHARACTERISTICS

Waste characteristics for the air pathway are evaluated using the exposed surface area of waste materials (sources) at the site, the concentrations of constituents in samples of the waste material, the background concentrations, and the EPA HRS human toxicity and ecotoxicity values (SCDM, 1993).

#### 4.2.1 Quantity

A quantity value is assigned according to measured estimates of exposed surface areas (in 100's of square feet) for each solid matrix source(s) or portions of a source, for which analytical data exist. Each sample collected at a site is assigned an exposed surface area that the sample represents (sample surface area assignments are tabulated on the waste characteristics worksheet). If a discrete surface sample was collected, only those analyses are used. This sample surface area was derived based on the source surface area(s) that the composite sample analyses represents (see SOP regarding XRF analyses and sample compositing; see also the AMRB Sampling and Analysis Plan; Pioneer, 1993).

This differs significantly from the HRS waste characteristics score calculation. The HRS only considers the most toxic constituent found at the site, does not consider the concentration, and applies the most toxic constituent to the entire area of wastes at the site. The AIMSS scoring method more fairly evaluates relative risks between sites, accounting for site specific constituent concentrations and the varying toxicity of different constituents. This method more accurately discriminates between sites with higher concentrations or more toxic constituents in relation to sites with lower concentrations or less toxic constituents. However, it is also more difficult to calculate.

Each sampled source at the site will be scored separately. Assign the sample quantity value, the toxicity value, and the ecotoxicity value as follows:

| Range<br>(100's of sq. ft.) | Quantity<br>Value | Constituent | Human<br>Toxicity Value | Ecotoxicity<br>Value |
|-----------------------------|-------------------|-------------|-------------------------|----------------------|
| less than 10                | 0.001             | Antimony    | 10.                     | 0.                   |
| 10-100                      | 0.01              | Arsenic     | 10.                     | 0.01                 |
| 100-1,000                   | 0.1               | Barium      | 0.01                    | 0.001                |
| 1,000-10,000                | 1.                | Cadmium     | 10.                     | 1.                   |
| 10,000-100,000              | 10.               | Chromium    | 10.                     | 0.1                  |
| 100,000-1,000,000           | 100.              | Copper      | 0.                      | 0.1                  |
| more than 1,000,000         | 1,000.            | Iron        | 0.                      | 0.01                 |
|                             |                   | Lead        | 10.                     | 1.                   |
|                             |                   | Mercury     | 10.                     | 10.                  |
|                             |                   | Nickel      | 10.                     | 0.01                 |
|                             |                   | Zinc        | 0.01                    | 0.01                 |
|                             |                   | Thorium     | 10.                     | 10.                  |
|                             |                   | Uranium     | 10.                     | 10.                  |
|                             |                   | Cyanide     | 0.1                     | 1.                   |
|                             |                   | Asbestos    | 10.                     | 0.                   |

#### 4.2.2 Human Hazard

Calculated for each constituent (note: manganese is excluded, asbestos is included) as the product of the sample concentration (in mg/Kg) and human toxicity values (derived from the EPA HRS human toxicity values/1,000; SCDM, 1993). Solid sample concentrations are corrected by subtracting background concentrations, and using the difference in the calculation. A separate product is calculated for each element and the element-products are summed for each sample.

For sample #1:

Constituent 1: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

Constituent 2: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

Constituent n: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

The sum of the element-products is the human hazard value for sample #1 = \_\_\_\_\_

The human hazard value procedure is repeated for each sample collected at the site.

For sample #n:

Constituent 1: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

Constituent n: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

Sum of element-products (human hazard value) for sample #n = \_\_\_\_\_



The waste score (human) is calculated by multiplying the sample quantity value (Appendix B) and the human hazard value (calculated above) for each sample, summing the values for all samples, and then dividing by 10,000:

Sample #1: Sample quantity value x sample #1 human hazard value = \_\_\_\_\_

Sample #n: Sample quantity value x sample #n human hazard value = \_\_\_\_\_

The waste score (human) is the sum of the sample products divided by 10,000.

#### 4.2.3 Ecological Hazard

Calculated for each constituent (note: manganese is excluded) as the product of the sample concentration (corrected by subtracting out background, in mg/Kg) and ecotoxicity values (derived from the EPA HRS ecotoxicity values/1,000; SCDM, 1993, see table in section 4.2.1). A separate product is calculated for each element and the element-products are summed for each sample.

For sample #1:

Constituent 1: (Sample conc. - background conc.) x ecotoxicity value = \_\_\_\_\_

Constituent 2: (Sample conc. - background conc.) x ecotoxicity value = \_\_\_\_\_

Constituent n: (Sample conc. - background conc.) x ecotoxicity value = \_\_\_\_\_

The sum of element-products is the ecohazard value for sample #1 = \_\_\_\_\_

The ecohazard value procedure is repeated for each sample collected at the site.

For sample #n:

Constituent 1: (Sample conc. - background conc.) x ecotoxicity value = \_\_\_\_\_

Constituent n: (Sample conc. - background conc.) x ecotoxicity value = \_\_\_\_\_

Sum of element-products (ecohazard value) for sample #n = \_\_\_\_\_

The waste score (ecologic) is calculated by multiplying the sample quantity value (Appendix B) and the ecohazard value (calculated above) for each sample, summing the values for all samples, and then dividing by 10,000:

Sample #1: Sample quantity value x sample #1 ecohazard value = \_\_\_\_\_

Sample #n: Sample quantity value x sample #n ecohazard value = \_\_\_\_\_

The waste score (ecologic) is the sum of the sample products divided by 10,000.



#### 4.2.4 Air Pathway Waste Characteristics Score

The total air pathway waste characteristics score is the sum the waste score (human) and the waste score (ecologic).

### 4.3 AIR PATHWAY TARGETS

The air pathway targets score is evaluated by assessing population and environmental receptors near the site potentially affected by airborne releases of waste constituents from the site.

#### 4.3.1 Population Within 4 Miles

Population within a 4-mile radius of the site was determined from available census information on larger municipalities, and from maps and field observations for smaller municipalities and rural populations. The four-mile distance is the same as the HRS target distance limit for the air pathway. To account for uncertainty in the population figures, population is intervalized into ranges (ranges are from the HRS) and recorded on the site inventory form: 0; 1-10; 10-30; 30-100; 100-300; 300-1,000; 1,000-3,000; 3,000-10,000, and >10,000. The lower value of the range is used to be conservative in assigning a population score. This value is assigned as the population within 4 miles.

#### 4.3.2 Distance to Nearest Residence

The nearest residence score is an adjustment used to emphasize the greater risk to persons living close to the site (per the HRS). The distance to the nearest residence was observed during the site visit and recorded on the inventory form. Only the nearest residence is used (full-time or recreational use), regardless of the number or frequency of persons living at the residence. Assign a value as follows: less than 1000 feet = 10; between 1000 feet and 1/2 mile = 5; and, more than 1/2 mile or unknown = 0.

#### 4.3.3 Sensitive Environments

Sensitive environments on or near the site (within the 4-mile target distance limit) are assigned air target scores, as in the HRS. Sensitive environments were determined from the site visit and inspection of the MDFWP data base (wetlands, threatened and endangered species). Assign these values as follows:

Wetlands (5 acre minimum) observed or in MDFWP database = 10; otherwise = 0.

National or State parks or wilderness areas = 10; otherwise = 0.

Threatened/Endangered Species Habitat from MDFWP database = 5; otherwise = 0.

#### 4.3.4 Air Pathway Targets Score

The air pathway targets score is the sum of the above five values: population within 4 miles, nearest residence, wetlands, parks/wilderness, and threatened/endangered species habitat.

#### 4.4 AIR PATHWAY SCORE

The air pathway score is the product of the Air Likelihood of Release Score (section 4.1), the Air Waste Characteristics Score (section 4.2), and the Air Targets Score (section 4.3).

### 5.0 DIRECT CONTACT

The direct contact exposure route is evaluated using three factors: the likelihood of exposure, direct contact waste characteristics, and direct contact targets. The product of these three factors is the direct contact score.

#### 5.1 DIRECT CONTACT LIKELIHOOD OF EXPOSURE

The direct contact likelihood of exposure factor evaluates two subfactors for scoring: observed exposure and potential exposure.

##### 5.1.1 Observed Exposure

Observed exposure is defined in two ways: residences observed on or within 200 feet of wastes; and, recreational activities occurring at the site during the site inspection, or observed evidence of previous recreational use at the site. One or more constituents in the waste materials must be at a concentration more than three times the background concentration. For residences observed on or within 200 feet, score 200; for recreational use, score 50; if neither were observed, score 0; if both were observed, score 250.

##### 5.1.2 Potential Exposure

The potential for direct contact with constituents at the site is evaluated using two criteria: the accessibility of the wastes at the site; and, the distance to the nearest population or residence.

###### 5.1.2.1 Accessibility

Accessibility of wastes at the site is evaluated with respect to the presence of fences, signs, physical barriers, gates, or guards, that restrict access to the site wastes by residents or recreational users. These access restrictions must be intact and at least

partially effective at limiting access by people. The most easily accessible waste at the site is assigned a value as follows: easily accessible - no fences, gates, or signs = 20; moderately accessible - barbed wire fences, road gated, and signs posted = 10; difficult access - chain link fence, road gated & locked = 5; and, not accessible - site completely fenced, access road gated & locked, site guarded (does not include locked or manned access points more than 1/2 mile from the actual abandoned mine site) = 1.

#### 5.1.2.2 Distance to nearest population

The shortest distance from any waste material to the nearest population (town) or individual residence was recorded on the AMRB inventory form during the site visit. Use this distance to assign a value as follows: less than 1,000 feet = 20; between 1,000 feet and 1/2 mile = 10; and, greater than 1/2 mile = 5.

#### 5.1.2.3 Potential exposure score

Calculate the potential exposure score by multiplying the accessibility value by the distance value (Maximum score = 400).

#### 5.1.3 Direct Contact Likelihood of Exposure Score

The direct contact likelihood of exposure score is the sum of the observed exposure and potential exposure scores (Maximum score = 650).

### 5.2 DIRECT CONTACT WASTE CHARACTERISTICS

Waste characteristics for direct contact are evaluated using the exposed surface area of waste materials at the site, the concentrations of constituents in samples of the waste material, the background concentrations, and the EPA HRS human toxicity value (SCDM, 1993).

#### 5.2.1 Quantity

A quantity value is assigned in the same manner as for the air pathway (section 4.2.1). Each sampled source at the site will be scored separately. Assign the sample quantity value and the toxicity value as follows:

| Range<br>(100's of sq. ft.) | Quantity<br>Value | Element  | Human<br>Toxicity Value |
|-----------------------------|-------------------|----------|-------------------------|
| less than 10                | 0.001             | Antimony | 10.                     |
| 10-100                      | 0.01              | Arsenic  | 10.                     |
| 100-1,000                   | 0.1               | Barium   | 0.01                    |
| 1,000-10,000                | 1.                | Cadmium  | 10.                     |
| 10,000-100,000              | 10.               | Chromium | 10.                     |
| 100,000-1,000,000           | 100.              | Copper   | 0.                      |
| more than 1,000,000         | 1,000.            | Iron     | 0.                      |
|                             |                   | Lead     | 10.                     |
|                             |                   | Mercury  | 10.                     |
|                             |                   | Nickel   | 10.                     |
|                             |                   | Zinc     | 0.01                    |
|                             |                   | Thorium  | 10.                     |
|                             |                   | Uranium  | 10.                     |
|                             |                   | Cyanide  | 0.1                     |
|                             |                   | Asbestos | 10.                     |

### 5.2.2 Hazard

Calculated for each constituent (note: manganese is excluded, asbestos is included) as the product of the sample concentration (corrected by subtracting out background, in mg/Kg) and human toxicity values (derived from the EPA HRS human toxicity values/1,000; SCDM, 1993). A separate product is calculated for each element and the element-products are summed for each sample.

For sample #1:

Constituent 1: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

Constituent 2: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

Constituent n: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

The sum of the element-products is the hazard value for sample #1 = \_\_\_\_\_

The hazard value procedure is repeated for each sample collected at the site.

For sample #n:

Constituent 1: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

Constituent n: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

Sum of element-products (hazard value) for sample #n = \_\_\_\_\_



### 5.2.3 Direct Contact Waste Characteristics Score

The waste characteristics score is calculated by multiplying the sample quantity value (Appendix B) and the hazard value (calculated above) for each sample, summing the values for all samples, and then dividing by 10,000:

Sample #1: Sample quantity value x sample #1 hazard value = \_\_\_\_\_

Sample #n: Sample quantity value x sample #n hazard value = \_\_\_\_\_

The direct contact waste characteristics score is the sum of the sample products divided by 10,000.

## 5.3 DIRECT CONTACT TARGETS

The direct contact targets score is evaluated by assessing nearby receptors potentially affected by direct contact with waste constituents at the site.

### 5.3.1 Population Within 1 Mile

Population within a 1-mile radius of the site was determined from available census information on larger municipalities, and from maps and field observations for smaller municipalities and rural populations. The one-mile distance is the same as the HRS target distance limit for the direct contact (soil exposure pathway). To account for uncertainty in the population figures, population is intervalized into ranges (ranges are from the HRS) and recorded on the site inventory form: 0; 1-10; 10-30; 30-100; 100-300; 300-1,000; 1,000-3,000; 3,000-10,000, and >10,000. The lower value of the range is used to be conservative in assigning a population score. This value is assigned as the population within 1 mile.

### 5.3.2 Distance to Nearest Residence

The nearest residence score is an adjustment used to emphasize the relatively greater risk to persons living close to the site (per the HRS). The distance to the nearest residence was observed during the site visit and recorded on the inventory form. Only the nearest residence is used (full-time or recreational use), regardless of the number or frequency of persons living at the residence. Assign a value as follows: less than 1000 feet = 10; between 1000 feet and 1/2 mile = 5; and, more than 1/2 mile or unknown = 0.

### 5.3.3 Recreational Use

Recreational use of the site is an adjustment to account for direct contact with site wastes by persons who use the site for recreation, but do not live within the 1 mile radius around the site. The value is assigned based on an evaluation of several criteria, collectively

radius around the site. The value is assigned based on an evaluation of several criteria, collectively referred to as "attractiveness" in the HRS: proximity to populated areas, heavily travelled roads, or other recreation areas; uncommon features of the site which may attract recreationists; and, the amount of physical evidence of recreational use observed at the site. Assign a value as follows: high recreational use = 10; moderate use = 5; low use = 2; and, no use = 0.

#### 5.3.4 Direct Contact Targets Score

The direct contact targets score is the sum of the above three values: population within 1 mile, nearest residence, and recreational use.

#### 5.4 DIRECT CONTACT SCORE

The Direct Contact Score is the product of the Direct Contact Likelihood of Exposure Score (section 5.1), the Direct Contact Waste Characteristics Score (section 5.2), and the Direct Contact Targets Score (section 5.3).

### 6.0 MINE SITE HUMAN HEALTH AND ENVIRONMENTAL HAZARD SCORE

Sum the four pathway scores and divide by 100,000 to obtain the total site human health and environmental hazard score. [Groundwater Pathway Score (section 2.4) + Surface Water Pathway Score (section 3.4) + Air Pathway Score (section 4.4) + Direct Contact Score (section 5.4)] / 100,000 = Total Site Human Health and Environmental Hazard Score.

### 7.0 SITE SAFETY SCORE

The site safety score is evaluated using three factors: the safety threat (accessibility), safety hazards, and safety targets. The product of these three factors divided by 1,000 is the site safety score.

#### 7.1 SAFETY THREAT

The potential threat of human contact with safety hazards at a site is evaluated using the relative accessibility to the safety hazard. Accessibility is evaluated with respect to the presence of fences, signs, physical barriers, gates, or guards, that restrict access by residents or recreational users to the site hazards. These access restrictions must be intact and at least partially effective at limiting access by people. The most easily accessible hazard is scored as follows: easily accessible - no fences, gates, or signs = 20; moderately accessible - barbed wire fences, road gated, and signs posted = 10; difficult access - chain link fence, road gated & locked = 5; and, not accessible - site completely fenced, access road gated & locked, site guarded (does not include locked

accessibility score is the same as the accessibility score in the Direct Contact section (5.1.2.1).

### 7.1.1 Safety Threat Score

The safety threat score is the accessibility of site hazards (Maximum = 20).

## 7.2 SAFETY HAZARDS

Safety hazards at the site are scored using the product of the quantity of various hazards and the relative hazard value assigned for each type of hazard. These hazards were recorded on the inventory form during the site visit.

Sum the number of open, hazardous, near-vertical stopes and shafts. Open means an opening that is large enough for a child to fall into, hazardous means that the sides of the opening are steep enough that the opening could not be exited easily (i.e. by a child).

Sum the number of open adits or near-horizontal openings, that are large enough and open enough for a curious child to enter.

Sum the number of unstable highwalls or open pits. Unstable refers to slopes, cuts, undercut banks, or piles that are at a slope that is greater than the angle of repose.

Sum the number of hazardous structures at the site. Hazardous refers to structurally unstable buildings, not all old buildings at the site.

Note the presence of explosives (includes blasting caps and decomposed explosives) at the site.

Note the presence of other hazardous materials (asbestos, chemicals, not including petroleum products).

Each hazard is scored separately by multiplying the quantity of each hazard by a hazard score to determine a hazard value. Assign hazard values as follows:

| <u>Hazard and quantity</u>            | <u>Score</u> | <u>Hazard Value</u> |
|---------------------------------------|--------------|---------------------|
| Number of shafts and stopes           | x 100        | = _____             |
| Number of adits and tunnels           | x 50         | = _____             |
| Number of pits and unstable highwalls | x 75         | = _____             |
| Number of hazardous structures        | x 40         | = _____             |
| Explosives present on site            | = 50         | _____               |
| Other hazardous materials present     | = 100        | _____               |



### 7.2.1 Safety Hazards Score

Safety Hazards Score is the sum of all the above hazard values.

### 7.3 SAFETY TARGETS

The safety targets score is evaluated in the same manner as the direct contact targets.

#### 7.3.1 Population Within 1 Mile

Population within a 1-mile radius of the site is the same as in the direct contact targets section.

#### 7.3.2 Distance to Nearest Residence

The nearest residence score is the same as in the direct contact targets section.

#### 7.3.3 Recreational Use

The recreational use score is the same as in the direct contact targets section.

#### 7.3.4 Safety Targets Score

The safety targets score is the sum of the above three values: population within 1 mile, nearest residence, and recreational use.

### 7.4 SITE SAFETY SCORE

The Site Safety Score is the product of the Safety Threat Score (section 7.1), the Safety Hazards Score (section 7.2), and the Safety Targets Score (section 7.3) divided by 1,000.

## 8.0 REFERENCES

Federal Register, 1990. 40 CFR Part 300, Appendix A, 1990. Hazard Ranking System; Final Rule. Federal Register, Vol. 55, No. 241, Pages 51532-51667. Friday, December 14, 1990; Effective Date: March 14, 1991.

Pioneer, 1993. Final Sampling and Analysis Plan for the Abandoned Mines Hazardous Materials Inventory. Prepared for MDSL/AMRB by Pioneer Technical Services, Inc., August, 1993. Standard Operating Procedures are attached as Appendix B.

SCDM, 1993. Superfund Chemical Database Matrix (SCDM), Hazardous Substance Factor Values and Hazardous Substance Benchmarks (333 Substances), March 1993 version.





**APPENDIX A**

**ABBREVIATED AIMSS SCORING INSTRUCTIONS AND FORM**



## GROUNDWATER PATHWAY

### **Groundwater Likelihood of Release:**

Line 1: Observed release - An observed release is defined as a downgradient groundwater concentration at more than three times the upgradient groundwater concentration, for any constituent that can be attributed to the site. A constituent can be attributed to the site if the constituent exists in a source at the site at a concentration that is more than three times the background concentration. Groundwater concentrations can be measured in monitoring wells, domestic wells, or seeps/springs. Discharging adits are not considered observed releases for this score; they are considered sources and are evaluated later in the waste characteristics section. An observed release to groundwater, that can be documented using the above criteria, is assigned a score of 300, otherwise this score is 0.

Line 2: Exceedances - A downgradient groundwater concentration in a domestic use or monitoring well exceeding USEPA MCL's or MCLG's for a constituent that is attributable to the site, is assigned a score of 100, whether or not an observed release to groundwater can be documented.

Line 3: Potential to release - The potential to release constituents to groundwater is evaluated using two factors: the containment of the sources at the site with respect to engineered structures designed to mitigate effects to groundwater (e.g. liners, covers, runoff diversions); and, the estimated depth to groundwater.

Line 3a: Containment factor (use the least contained source):

|  |    |
|--|----|
| No containment                             | 20 |
| Liner, runoff diversions, or covered (one) | 10 |
| Two of the above three structures          | 5  |
| Completely contained (all of the above)    | 1  |

Line 3b: Estimated (or measured) depth to groundwater factor:

|                                      |    |
|--------------------------------------|----|
| Shallow (less than 25 feet to water) | 20 |
| Moderate (25 to 100 feet)            | 10 |
| Deep (greater than 100 feet)         | 2  |

Line 3c: Calculate the potential to release score by multiplying the containment factor by the depth factor (Maximum = 400).

**Line 4: Groundwater Likelihood of Release Score** is the sum of the observed release, exceedances, and potential to release scores (Maximum = 800).



## Line 5: Groundwater Waste Characteristics:

**Quantity** - A quantity value is assigned according to estimated volumes in cubic yards (cy) for each solid matrix source(s) or portions of a source, for which analytical data were collected. Each sample collected at a site has been assigned a volume that the sample represents (sample volume assignments are tabulated on the waste characteristics worksheet). This representative volume was derived based on the source volume(s) that the composite sample analysis represents (see SOP regarding XRF analyses and sample compositing; see also the AMRB Sampling and Analysis Plan). Also, assign a value for each measured and sampled adit discharge in gallons per day (gpd = cubic feet per second X 646,272 gpd/cfs). Each media (solid or water) and sampled source at the site will be scored separately. Assign the sample quantity value as follows:

| <u>Range</u><br>(cy or gpd) | <u>Quantity</u><br><u>Value</u> | <u>Element</u> | <u>Human</u><br><u>Toxicity Value</u> |
|-----------------------------|---------------------------------|----------------|---------------------------------------|
| less than 10                | 0.003                           | Antimony       | 10.                                   |
| 10-30                       | 0.01                            | Arsenic        | 10.                                   |
| 30-100                      | 0.03                            | Barium         | 0.01                                  |
| 100-300                     | 0.1                             | Cadmium        | 10.                                   |
| 300-1,000                   | 0.3                             | Chromium       | 10.                                   |
| 1,000-3,000                 | 1.                              | Copper         | 0.                                    |
| 3,000-10,000                | 3.                              | Iron           | 0.                                    |
| 10,000-30,000               | 10.                             | Lead           | 10.                                   |
| 30,000-100,000              | 30.                             | Mercury        | 10.                                   |
| 100,000-300,000             | 100.                            | Nickel         | 10.                                   |
| 300,000-1,000,000           | 300.                            | Zinc           | 0.01                                  |
| greater than 1,000,000      | 1,000.                          | Thorium        | 10.                                   |
|                             |                                 | Uranium        | 10.                                   |
|                             |                                 | Cyanide        | 0.1                                   |
|                             |                                 | Asbestos       | 10.                                   |

**Hazard** - Calculated per element as the product of the sample concentration (corrected by subtracting out background, solids in mg/Kg or water in ug/L) and toxicity values (derived from the EPA HRS human toxicity values/1,000; see table above). Note manganese and asbestos are excluded from the groundwater calculation. A separate product is calculated for each element and the element-products are summed for each sample.

For sample #1:

Element 1: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_  
Element n: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_  
Sum of element-products (hazard score) for sample #1 = \_\_\_\_\_

For sample #n:

Element 1: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

Element n: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

Sum of element-products (hazard score) for sample #n = \_\_\_\_\_

The waste characteristics score is calculated by multiplying the sample quantity value and the hazard score for each sample, summing the values for all samples, and then dividing by 10,000:

Sample #1: Sample quantity value x sample #1 hazard score = \_\_\_\_\_

Sample #n: Sample quantity value x sample #n hazard score = \_\_\_\_\_

**Line 5: Groundwater Waste Characteristics Score**

Sum the sample quantity-hazard products \_\_\_\_\_ / 10,000.

**Groundwater Targets:**

Line 6: Number of wells within 1 mile x 2.5 persons/well = \_\_\_\_\_

Line 7: Number of wells located between 1 and 4 miles = \_\_\_\_\_

Line 8: Distance to nearest well:

Less than 1000 feet = 10

1000 feet to 1/2 mile (2,640 feet) = 5

more than 1/2 mile or unknown = 0

= \_\_\_\_\_

**Line 9: Groundwater Targets Score** - sum of these three values. = \_\_\_\_\_

**LINE 10:** The **GROUNDWATER PATHWAY SCORE** is the product of the Groundwater Likelihood of Release Score (Line 4), the Groundwater Waste Characteristics Score (Line 5), and the Groundwater Targets Score (Line 9).

**SURFACE WATER PATHWAY**

**Surface Water Likelihood of Release:**

Line 11: Observed release - An observed release is defined as a downstream surface water or stream sediment concentration at more than three times the upstream surface water or sediment concentration, for any constituent that can be attributed to the site. A constituent can be attributed to the site if the constituent exists in a source at the site at a concentration that is more than three times the background concentration. Discharging adits are not considered observed releases for this score; they are

considered sources and are evaluated later in the waste characteristics section. An observed release to surface water, that can be documented using the above criteria, is assigned a score of 300, otherwise this score is 0.

**Line 12: Exceedances** - A downstream surface water concentration that exceeds USEPA MCL's or MCLG's for a constituent that is attributable to the site, is assigned a score of 100, whether or not an observed release to surface water can be documented. A downstream surface water concentration exceeding USEPA or State acute AWQC's, but not MCL's, for a constituent that is attributable to the site, is assigned a score of 50 (do not add 50 if MCL's are exceeded).

**Line 13: Potential to release** - The potential to release constituents to surface water is evaluated using two factors: the containment of the sources at the site with respect to engineered structures designed to mitigate effects to surface water (via flooding and storm runoff) including dams, diversions, sediment basins, or other intact engineered systems; and, the shortest distance from any waste material to the nearest surface water body.

**Line 13a: Containment factor (use the least contained source):**

|  |    |
|--|----|
| No functioning containment structures              | 20 |
| One of the containment structures listed above     | 10 |
| Completely contained with respect to surface water | 1  |

**Line 13b: Distance from waste material to nearest surface water:**

|                         |    |
|-------------------------|----|
| Less than 25 feet       | 20 |
| Between 25 and 100 feet | 10 |
| Greater than 100 feet   | 2  |

**Line 13c:** Calculate the potential to release score by multiplying the containment factor by the distance factor (Maximum = 400).

**Line 14: Surface Water Likelihood of Release Score** is the sum of the observed release, exceedances, and potential to release scores (Maximum = 800).

**Line 15: Surface Water Waste Characteristics:**

**Quantity** - A quantity value is assigned according to estimated volumes in cubic yards (cy) for each solid matrix source(s) or portions of a source, for which analytical data were collected. Each sample collected at a site has been assigned a volume that the sample represents (sample volume assignments are tabulated on the waste characteristics worksheet). This representative volume was derived based on the source volume(s) that the composite sample analysis represents (see SOP regarding XRF analyses and sample compositing; see also the AMRB Sampling and Analysis



Plan). Also, assign a value for each measured and sampled adit discharge in gallons per day (gpd = cubic feet per second X 646,272 gpd/cfs). Each media (solid or water) and sampled source at the site will be scored separately. Assign the sample quantity value as follows:

| <u>Range</u><br><u>(cy or gpd)</u> | <u>Quantity</u><br><u>Value</u> | <u>Element</u> | <u>Human</u><br><u>Toxicity Value</u> | <u>Ecotoxicity</u><br><u>Value</u> |
|------------------------------------|---------------------------------|----------------|---------------------------------------|------------------------------------|
| less than 10                       | 0.003                           | Antimony       | 10.                                   | 0.                                 |
| 10-30                              | 0.01                            | Arsenic        | 10.                                   | 0.01                               |
| 30-100                             | 0.03                            | Barium         | 0.01                                  | 0.001                              |
| 100-300                            | 0.1                             | Cadmium        | 10.                                   | 1.                                 |
| 300-1,000                          | 0.3                             | Chromium       | 10.                                   | 0.1                                |
| 1,000-3,000                        | 1.                              | Copper         | 0.                                    | 0.1                                |
| 3,000-10,000                       | 3.                              | Iron           | 0.                                    | 0.01                               |
| 10,000-30,000                      | 10.                             | Lead           | 10.                                   | 1.                                 |
| 30,000-100,000                     | 30.                             | Mercury        | 10.                                   | 10.                                |
| 100,000-300,000                    | 100.                            | Nickel         | 10.                                   | 0.01                               |
| 300,000-1,000,000                  | 300.                            | Zinc           | 0.01                                  | 0.01                               |
| greater than 1,000,000             | 1,000.                          | Thorium        | 10.                                   | 10.                                |
|                                    |                                 | Uranium        | 10.                                   | 10.                                |
|                                    |                                 | Cyanide        | 0.1                                   | 1.                                 |
|                                    |                                 | Asbestos       | 10.                                   | 0.                                 |

Human Hazard - Calculated per element as the product of the sample concentration (corrected by subtracting out background, solids in mg/Kg or water in ug/L) and toxicity values (derived from the EPA HRS human toxicity values/1,000; see table above). A separate product is calculated for each element and the element-products are summed for each sample.

For sample #1:

Element 1: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_  
 Element n: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_  
 Sum of element-products (hazard score) for sample #1 = \_\_\_\_\_

For sample #n:

Element 1: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_  
 Element n: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_  
 Sum of element-products (hazard score) for sample #n = \_\_\_\_\_

The waste score (human) is calculated by multiplying the quantity value and the hazard score for each sample, summing the values for all samples, and then dividing by 10,000:

Sample #1: Sample quantity value x sample #1 hazard score = \_\_\_\_\_  
 Sample #n: Sample quantity value x sample #n hazard score = \_\_\_\_\_  
 Sum of source-products (Waste Score - Human) for site = \_\_\_\_\_ /10,000.



**Ecological Hazard** - Calculated per element as the product of the sample concentration (corrected by subtracting out background, solids in mg/Kg or water in ug/L) and ecotoxicity values (derived from the EPA HRS ecotoxicity values/1,000; see table above). A separate product is calculated for each element and the element-products are summed for each sample.

For source #1:

Element 1: (Sample conc. - background conc.) x ecotoxicity value = \_\_\_\_\_  
Element n: (Sample conc. - background conc.) x ecotoxicity value = \_\_\_\_\_  
Sum of element-products (ecohazard score) for sample #1 = \_\_\_\_\_

For source #n:

Element 1: (Sample conc. - background conc.) x ecotoxicity value = \_\_\_\_\_  
Element n: (Sample conc. - background conc.) x ecotoxicity value = \_\_\_\_\_  
Sum of element-products (ecohazard score) for sample #n = \_\_\_\_\_

The waste score (ecologic) is calculated by multiplying the quantity value and the ecohazard score for each sample, summing the values for all samples, and then dividing by 10,000:

Sample #1: Sample quantity value x sample #1 ecohazard score = \_\_\_\_\_  
Sample #n: Sample quantity value x sample #n ecohazard score = \_\_\_\_\_  
Sum of source-products (Waste Score - Ecologic) for site = \_\_\_\_\_ /10,000.

**Line 15: Surface Water Waste Characteristics Score -**

Sum the Waste Score (Human) and the Waste Score (Ecologic).

**Surface Water Targets Score:**

Line 16: Number of persons using surface water for drinking water within 15 miles downstream, adjusted for dilution. = \_\_\_\_\_

Line 17: Distance (in 1,000's of feet) of impacted drainage(s) downstream from the site with respect to sedimentation or acid mine drainage characteristics. = \_\_\_\_\_

Other surface water uses within 15 miles downstream:

Line 18: Wetlands (5 acre minimum) = 10 = \_\_\_\_\_

Line 19: Fishery - Class 1 = 20  
Class 2 = 10  
Class 3 = 5  
Class 4 = 1 = \_\_\_\_\_

Line 20: Recreational use = 5 = \_\_\_\_\_

Line 21: Irrigation / Stock watering use = 2 = \_\_\_\_\_

Line 22: Threatened / Endangered Species Habitat = 5 = \_\_\_\_\_

**Line 23: Surface Water Targets Score** - sum of the above seven values.

**LINE 24:** The **SURFACE WATER PATHWAY SCORE** is the product of the Surface Water Likelihood of Release Score (Line 14), the Surface Water Waste Characteristics Score (Line 15), and the Surface Water Targets Score (Line 23).

### **AIR PATHWAY**

#### **Air Likelihood of Release:**

Line 25: Observed release - An observed release is defined in three ways: materials that were observed blowing off the site during the site inspection; evidence of wind deposited wastes was observed away from the waste sources (e.g. dunes); or, anecdotal evidence from other investigators, residents, or other reliable sources. One or more constituents in the source must be at a concentration that is more than three times the background concentration. A score of 200 is assigned for an observed release to the air pathway meeting the above criteria, otherwise score 0.

Line 26: Potential to release - The potential to release constituents to the air pathway is evaluated using two factors: the containment of the sources with respect to dust emissions (topsoil, vegetative cover, or perennially wet); and, the distance to the nearest population or residence.

Line 26a: Containment factor (use the highest dust propagation potential noted on the inventory form during the site inspection - based on % cover, available fines, and moisture content):

|                                 |    |
|---------------------------------|----|
| High dust propagation potential | 20 |
| Moderate                        | 15 |
| Low                             | 10 |
| None                            | 1  |

Line 26b: Distance from any source to the nearest population or residence:

|                                    |    |
|------------------------------------|----|
| Less than 1000 feet                | 20 |
| 1000 feet to 1/2 mile (2,640 feet) | 10 |
| Greater than 1/2 mile              | 5  |

Line 26c: Calculate the potential to release score by multiplying the containment factor by the distance factor (Maximum = 400).

**Line 27: Air Likelihood of Release Score** is the sum of the observed release and potential to release scores (Maximum = 600).

**Line 28: Air Waste Characteristics:**

Quantity - A quantity value is assigned according to estimated exposed surface areas (in 100's of square feet) for each solid matrix source(s) or portions of a source, for which analytical data were collected. Each sample collected at a site has been assigned a surface area that the sample represents (sample surface area assignments are tabulated on the waste characteristics worksheet). If a discrete surface sample was collected, only those analyses are used. This representative area was derived based on the source surface area(s) that the composite sample analysis represents (see SOP regarding XRF analyses and sample compositing; see also the AMRB Sampling and Analysis Plan). Each sampled source at the site will be scored separately. Assign the sample quantity value as follows:

| Range<br>(100's of sq. ft.) | Quantity<br>Value | Element  | Human<br>Toxicity Value | Ecotoxicity<br>Value |
|-----------------------------|-------------------|----------|-------------------------|----------------------|
| less than 10                | 0.001             | Antimony | 10.                     | 0.                   |
| 10-100                      | 0.01              | Arsenic  | 10.                     | 0.01                 |
| 100-1,000                   | 0.1               | Barium   | 0.01                    | 0.001                |
| 1,000-10,000                | 1.                | Cadmium  | 10.                     | 1.                   |
| 10,000-100,000              | 10.               | Chromium | 10.                     | 0.1                  |
| 100,000-1,000,000           | 100.              | Copper   | 0.                      | 0.1                  |
| greater than 1,000,000      | 1,000.            | Iron     | 0.                      | 0.01                 |
|                             |                   | Lead     | 10.                     | 1.                   |
|                             |                   | Mercury  | 10.                     | 10.                  |
|                             |                   | Nickel   | 10.                     | 0.01                 |
|                             |                   | Zinc     | 0.01                    | 0.01                 |
|                             |                   | Thorium  | 10.                     | 10.                  |
|                             |                   | Uranium  | 10.                     | 10.                  |
|                             |                   | Cyanide  | 0.1                     | 1.                   |
|                             |                   | Asbestos | 10.                     | 0.                   |

Human Hazard - Calculated per element as the product of the sample concentration (corrected by subtracting out background, in mg/Kg) and toxicity values (derived from the EPA HRS human toxicity values/1,000; see table above). A separate product is calculated for each element and the element-products are summed for each sample.

For sample #1:

Element 1: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_  
 Element n: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_  
 Sum of element-products (hazard score) for sample #1 = \_\_\_\_\_

For sample #n:

Element 1: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

Element n: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

Sum of element-products (hazard score) for sample #n = \_\_\_\_\_

The waste score (human) is calculated by multiplying the quantity value and the hazard score for each sample, summing the values for all samples, and then dividing by 10,000:

Sample #1: Sample quantity value x sample #1 hazard score = \_\_\_\_\_

Sample #n: Sample quantity value x sample #n hazard score = \_\_\_\_\_

Sum of source-products (Waste Score - Human) for site = \_\_\_\_\_ /10,000.

Ecological Hazard - Calculated per element as the product of the sample concentration (corrected by subtracting out background, in mg/Kg) and ecotoxicity values (derived from the EPA HRS ecotoxicity values/1,000; see table above). A separate product is calculated for each element and the element-products are summed for each sample.

For source #1:

Element 1: (Sample conc. - background conc.) x ecotoxicity value = \_\_\_\_\_

Element n: (Sample conc. - background conc.) x ecotoxicity value = \_\_\_\_\_

Sum of element-products (ecohazard score) for sample #1 = \_\_\_\_\_

For source #n:

Element 1: (Sample conc. - background conc.) x ecotoxicity value = \_\_\_\_\_

Element n: (Sample conc. - background conc.) x ecotoxicity value = \_\_\_\_\_

Sum of element-products (ecohazard score) for sample #n = \_\_\_\_\_

The waste score (ecologic) is calculated by multiplying the quantity value and the ecohazard score for each sample, summing the values for all samples, and then dividing by 10,000:

Sample #1: Sample quantity value x sample #1 ecohazard score = \_\_\_\_\_

Sample #n: Sample quantity value x sample #n ecohazard score = \_\_\_\_\_

Sum of source-products (Waste Score - Ecologic) for site = \_\_\_\_\_ /10,000.

**Line 28: Air Waste Characteristics Score -**

Sum the Waste Score (Human) and the Waste Score (Ecologic).

**Air Targets:**

Line 29: Population within 4 miles of the site

(use the lower value of range on the inventory form). = \_\_\_\_\_



Line 30: Distance to the nearest residence:

Less than 1000 feet = 10

1000 feet to 1/2 mile (2,640 feet) = 5

Greater than 1/2 mile = 0

= \_\_\_\_\_

Sensitive environments on or near the site:

Line 31: Wetlands = 10

= \_\_\_\_\_

Line 32: National or State Parks / Wilderness = 10

= \_\_\_\_\_

Line 33: Threatened or Endangered Species habitat = 5

= \_\_\_\_\_

**Line 34: Air Targets Score** - sum of the above five values.

**LINE 35:** The **AIR PATHWAY SCORE** is the product of the Air Likelihood of Release Score (Line 27), the Air Waste Characteristics Score (Line 28), and the Air Targets Score (Line 34).

### **DIRECT CONTACT**

#### **Direct Contact Likelihood of Exposure:**

Line 36: Observed exposure - Observed exposure is defined in two ways: residences observed on or within 200 feet of a source; and, recreation activities on sources during the site inspection, or observed evidence of previous recreational use at the site. One or more constituents in the source must be at a concentration that is more than three times the background concentration. For residences, score 200; for recreation use, score 50; if neither were observed, score 0; if both were observed, score 250.

Line 37: Potential exposure - The potential for direct contact with constituents at the site is evaluated using two factors: the accessibility of the sources with respect to residents or recreational use (e.g. fences, signs, physical barriers, guards/watchmen); and, the distance to the nearest population or residence.

Line 37a: Accessibility of the site sources (most accessible source):

Easily accessible (no fences, gates, or signs) 20

Moderate (barbed wire fences, gated and signs) 10

Difficult (chain link fence, road gated & locked) 5

Not accessible (fence, road gated & locked, site manned) 1

Line 37b: Distance to nearest population or residence:

|                                    |    |
|------------------------------------|----|
| Less than 1000 feet                | 20 |
| 1000 feet to 1/2 mile (2,640 feet) | 10 |
| Greater than 1/2 mile              | 5  |

Line 37c: Calculate the potential exposure score by multiplying the accessibility factor by the distance factor (Maximum = 400).

**Line 38: Direct Contact Likelihood of Exposure Score** is calculated as the sum of the observed exposure and potential exposure scores (Maximum = 650).

**Line 39: Direct Contact Waste Characteristics:**

Quantity - A quantity value is assigned according to estimated exposed surface areas (in 100's of square feet) for each solid matrix source(s) or portions of a source, for which analytical data were collected. Each sample collected at a site has been assigned a surface area that the sample represents (sample surface area assignments are tabulated on the waste characteristics worksheet). If a discrete surface sample was collected, only those analyses are used. This representative area was derived based on the source surface area(s) that the composite sample analysis represents (see SOP regarding XRF analyses and sample compositing; see also the AMRB Sampling and Analysis Plan). Each sampled source at the site will be scored separately. Assign the sample quantity value as follows:

| <u>Range</u><br>(100's of sq. ft.) | <u>Quantity</u><br><u>Value</u> | <u>Element</u> | <u>Human</u><br><u>Toxicity Value</u> |
|------------------------------------|---------------------------------|----------------|---------------------------------------|
| less than 10 (1,000 sq. ft.)       | 0.001                           | Antimony       | 10.                                   |
| 10-100                             | 0.01                            | Arsenic        | 10.                                   |
| 100-1,000                          | 0.1                             | Barium         | 0.01                                  |
| 1,000-10,000                       | 1.                              | Cadmium        | 10.                                   |
| 10,000-100,000                     | 10.                             | Chromium       | 10.                                   |
| 100,000-1,000,000                  | 100.                            | Copper         | 0.                                    |
| greater than 1,000,000             | 1,000.                          | Iron           | 0.                                    |
|                                    |                                 | Lead           | 10.                                   |
|                                    |                                 | Mercury        | 10.                                   |
|                                    |                                 | Nickel         | 10.                                   |
|                                    |                                 | Zinc           | 0.01                                  |
|                                    |                                 | Thorium        | 10.                                   |
|                                    |                                 | Uranium        | 10.                                   |
|                                    |                                 | Cyanide        | 0.1                                   |
|                                    |                                 | Asbestos       | 10.                                   |

**Hazard** - Calculated per element as the product of the sample concentration (corrected by subtracting out background, in mg/Kg) and toxicity values (derived from the EPA HRS human toxicity values/1,000; see table above). A separate product is calculated for each element and the element-products are summed for each sample.

For sample #1:

Element 1: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

Element n: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

Sum of element-products (hazard score) for sample #1 = \_\_\_\_\_

For sample #n:

Element 1: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

Element n: (Sample conc. - background conc.) x Human toxicity value = \_\_\_\_\_

Sum of element-products (hazard score) for sample #n = \_\_\_\_\_

The waste characteristics score is calculated by multiplying the quantity value and the hazard score for each sample, summing the values for all samples, and then dividing by 10,000:

Sample #1: Sample quantity value x sample #1 hazard score = \_\_\_\_\_

Sample #n: Sample quantity value x sample #n hazard score = \_\_\_\_\_

**Line 39: Direct Contact Waste Characteristics Score**

Sum the sample quantity-hazard products \_\_\_\_\_ / 10,000.

**Direct Contact Targets:**

Line 40: Population within 1 mile of the site

(use the lower value of range on inventory form). = \_\_\_\_\_

Line 41: Distance to nearest residence:

Less than 1000 feet = 10

1000 feet to 1/2 mile (2,640 feet) = 5

Greater than 1/2 mile = 0

= \_\_\_\_\_

Line 42: Recreational use of the site:

High = 10

Moderate = 5

Low = 2

None = 0

= \_\_\_\_\_

**Line 43: Direct Contact Targets Score** - sum of the above three values.

**LINE 44:** The **DIRECT CONTACT SCORE** is the product of the Direct Contact Likelihood of Exposure Score (Line 38), the Direct Contact Waste Characteristics Score (Line 39), and the Direct Contact Targets Score (Line 43).

**LINE 45: MINE SITE HUMAN HEALTH AND ENVIRONMENTAL HAZARD SCORE**

Sum the four pathway scores and divide by 100,000 to obtain the total site human health and environmental hazard score. [Groundwater pathway score + Surface water pathway score + Air pathway score + Direct contact score] / 100,000 = Total site human health and environmental hazard score.

**SITE SAFETY SCORE**

**Safety Threat:**

The potential threat of contact with safety hazards at a site is evaluated using the relative accessibility of the safety hazard with respect to nearby residents and/or recreational users (e.g. fences, signs, physical barriers, guards/watchmen).

Line 1: Accessibility of the site hazards (most accessible hazard):

|  |    |
|--|----|
| Easily accessible (no fences, gates, or signs)           | 20 |
| Moderate (barbed wire fences, gated and signs)           | 10 |
| Difficult (chain link fence, road gated & locked)        | 5  |
| Not accessible (fence, road gated & locked, site manned) | 1  |

**Line 1: Safety Threat Score** is the accessibility of site hazards (Maximum = 20).

**Safety Hazards:**

Sum the number of open near-vertical stopes and shafts that are large enough for a child to fall into. Sum the number of open adits or near-horizontal openings large enough for a child to enter.

Sum the number of unstable (slope greater than angle of repose) highwalls or open pits. Sum the number of hazardous structures (structurally unstable) at the site. Note the presence of explosives or other hazardous materials (asbestos, chemicals, not petroleum products).



| Hazard and quantity                       | Score | Hazard Value |
|---|-------|--------------|
| Line 2: # of shafts and stopes            | x 100 | =            |
| Line 3: # of adits and tunnels            | x 50  | =            |
| Line 4: # of pits and unstable highwalls  | x 75  | =            |
| Line 5: # of hazardous structures         | x 40  | =            |
| Line 6: Explosives present on site        | = 50  |              |
| Line 7: Other hazardous materials present | = 100 |              |

A14

# AIMSS SCORESHEET

SITE NAME: \_\_\_\_\_  
PA NUMBER: \_\_\_\_\_

| LINE NO.                      | GROUNDWATER PATHWAY  |                       |                     |
|-------------------------------|--|-----------------------|---------------------|
| 1                             |  | OBSERVED RELEASE      |                     |
| 2                             |  | EXCEEDENCES           |                     |
| 3A                            | GW - LIKELIHOOD OF RELEASE   | CONTAINMENT           |                     |
| 3B                            |  | GW DEPTH              |                     |
| 3C                            |  | POTENTIAL TO RELEASE  | LINES 3A x 3B       |
| 4                             |  | LIKELIHOOD SCORE      | LINES 1 + 2 + 3C    |
| 5                             | GW - WASTE CHAR.   | CALCULATED SCORE      | (SEE WORKSHEET)     |
| 6                             | GW - TARGETS   | WELLS - 1 MI. x 2.5   |                     |
| 7                             |  | WELLS - 1 TO 4 MI     |                     |
| 8                             |  | NEAREST WELL          |                     |
| 9                             |  | TARGETS SCORE         | LINES 6 + 7 + 8     |
| 10                            |  | GROUNDWATER SCORE     | LINES 4 x 5 x 9     |
| <b>SURFACE WATER PATHWAY</b>  |  |                       |                     |
| 11                            | SW - LIKELIHOOD OF RELEASE   | OBSERVED RELEASE      |                     |
| 12                            |  | EXCEEDENCES           |                     |
| 13A                           |  | CONTAINMENT           |                     |
| 13B                           |  | DISTANCE TO SW        |                     |
| 13C                           |  | POTENTIAL TO RELEASE  | LINES 13A x 13B     |
| 14                            |  | LIKELIHOOD SCORE      | LINES 11 + 12 + 13C |
| 15                            | SW - WASTE CHAR.   | CALCULATED SCORE      | (SEE WORKSHEET)     |
| 16                            | SW - TARGETS   | DRINKING WATER POP'N  |                     |
| 17                            |  | IMPACTED DRAINAGE     |                     |
| 18                            |  | WETLANDS              |                     |
| 19                            |  | FISHERY               |                     |
| 20                            |  | RECREATION            |                     |
| 21                            |  | IRRIGATION/STOCK      |                     |
| 22                            |  | T & E SPECIES HABITAT |                     |
| 23                            |  | TARGETS SCORE         | SUM LINES 16 - 22   |
| 24                            |  | SURFACE WATER SCORE   | LINES 14 x 15 x 23  |
| <b>AIR PATHWAY</b>            |  |                       |                     |
| 25                            | AIR - LIKELIHOOD OF RELEASE  | OBSERVED RELEASE      |                     |
| 26A                           |  | CONTAINMENT           |                     |
| 26B                           |  | DISTANCE TO POP'N     |                     |
| 26C                           |  | POTENTIAL TO RELEASE  | LINES 26A x 26B     |
| 27                            |  | LIKELIHOOD SCORE      | LINES 25 + 26C      |
| 28                            | AIR - WASTE CHAR.  | CALCULATED SCORE      | (SEE WORKSHEET)     |
| 29                            | AIR - TARGETS  | POPULATION - 4 MILES  |                     |
| 30                            |  | NEAREST RESIDENCE     |                     |
| 31                            |  | WETLANDS              |                     |
| 32                            |  | PARKS / WILDERNESS    |                     |
| 33                            |  | T & E SPECIES HABITAT |                     |
| 34                            |  | TARGETS SCORE         | SUM LINES 29 - 33   |
| 35                            |  | AIR PATHWAY SCORE     | LINES 27 x 28 x 34  |
| <b>DIRECT CONTACT PATHWAY</b> |  |                       |                     |
| 36                            | LIKELIHOOD OF EXPOSURE   | OBSERVED EXPOSURE     |                     |
| 37A                           |  | ACCESSIBILITY         |                     |
| 37B                           |  | DISTANCE TO POP'N     |                     |
| 37C                           |  | POTENTIAL EXPOSURE    | LINES 37A x 37B     |
| 38                            |  | LIKELIHOOD SCORE      | LINES 36 + 37C      |
| 39                            | D. C. WASTE CHAR.  | CALCULATED SCORE      | (SEE WORKSHEET)     |
| 40                            | DIRECT CONTACT TARGETS   | POPULATION - 1 MILE   |                     |
| 41                            |  | NEAREST RESIDENCE     |                     |
| 42                            |  | RECREATIONAL USE      |                     |
| 43                            |  | TARGETS SCORE         | SUM LINES 40 - 42   |
| 44                            |  | DIRECT CONTACT SCORE  | LINES 38 x 39 x 43  |
| 45                            | TOTAL SITE HUMAN & ENVIRONMENTAL HAZARD SCORE<br>(LINES 10 + 24 + 35 + 44) / 100,000 |                       |                     |

| SITE SAFETY |         |                        |                            |
|-------------|---------|------------------------|----------------------------|
| 1           | THREAT  | ACCESSIBILITY          |                            |
| 2           | HAZARDS | OPEN SHAFTS            | 100 EA.                    |
| 3           |         | OPEN ADITS             | 50 EA.                     |
| 4           |         | UNSTAB. HIWALLS / PITS | 75 EA.                     |
| 5           |         | HAZ. STRUCTURES        | 40 EA.                     |
| 6           |         | EXPLOSIVES             |                            |
| 7           |         | HAZ. MATERIALS         |                            |
| 8           |         | HAZARDS SCORE          | SUM LINES 2 - 7            |
| 9           | TARGETS | POPULATION - 1 MILE    |                            |
| 10          |         | NEAREST RESIDENCE      |                            |
| 11          |         | RECREATIONAL USE       |                            |
| 12          |         | TARGETS SCORE          | SUM LINES 9 - 11           |
| 13          |         | SITE SAFETY SCORE      | (LINES 1 x 8 x 12) / 1,000 |

**APPENDIX B**

**WASTE CHARACTERISTICS WORKSHEET**





# WASTE CHARACTERISTICS SCORE WORKSHEET

| PA<br>NUMBER | SAMPLE<br>NUMBER | WASTE<br>VOLUME<br>(CU. YD.) | UNCOV<br>WASTE<br>AREA<br>(SQ. FT.) | ADIT<br>FLOW<br>(CFS) | GRND W.<br>WASTE<br>CHAR.<br>SCORE | SURF W.<br>WASTE<br>CHAR.<br>SCORE | AIR<br>WASTE<br>CHAR.<br>SCORE | DIR. CONT.<br>WASTE<br>CHAR.<br>SCORE |
|--------------|------------------|------------------------------|-------------------------------------|-----------------------|------------------------------------|------------------------------------|--------------------------------|---------------------------------------|
| 01-005       | 01-005-TP-1      | 200000                       | 333000                              | 0.000                 | 352.8028                           | 356.2894                           | 3.5629                         | 3.5280                                |
| 01-006       | APEX MILL- TP1   | 19000                        | 29700                               | 0.000                 | 8.6576                             | 11.6738                            | 0.1167                         | 0.0866                                |
| 01-006       | APEX MILL- TP2   | 50800                        | 62100                               | 0.000                 | 32.2655                            | 36.9872                            | 0.1233                         | 0.1076                                |
| 01-031       | 01-031-TP-1      | 34850                        | 76375                               | 0.000                 | 33.9503                            | 38.5126                            | 0.1284                         | 0.1132                                |
| 01-031       | 01-031-TP-2      | 34850                        | 76375                               | 0.000                 | 40.5501                            | 46.4774                            | 0.1549                         | 0.1352                                |
| 01-031       | 01-031-TP-3      | 18700                        | 63000                               | 0.000                 | 4.9325                             | 5.7078                             | 0.0571                         | 0.0493                                |
| 01-031       | 01-031-WR-1      | 17000                        | 31680                               | 0.000                 | 0.0193                             | 0.4324                             | 0.0043                         | 0.0002                                |
| 01-031       | 01-031-WR-2      | 240000                       | 438975                              | 0.000                 | 6.8079                             | 11.2842                            | 0.1128                         | 0.0681                                |
| 01-034       | 01-034-WR-1      | 2233                         | 8400                                | 0.000                 | 1.1876                             | 1.4770                             | 0.0148                         | 0.0119                                |
| 01-034       | 01-034-SG-1      | 2600                         | 10800                               | 0.000                 | 0.1161                             | 0.3208                             | 0.0321                         | 0.0116                                |
| 01-034       | 01-034-WR-2      | 4467                         | 16800                               | 0.000                 | 1.0974                             | 1.1461                             | 0.0382                         | 0.0366                                |
| 01-034       | 01-034-WR-3      | 2920                         | 10125                               | 0.000                 | 5.6619                             | 5.9152                             | 0.5915                         | 0.5662                                |
| 01-034       | 01-034-WR-4      | 5870                         | 18090                               | 0.000                 | 3.4892                             | 3.7654                             | 0.1255                         | 0.1163                                |
| 01-092       | 01-092-WR-1      | 500                          | 63000                               | 0.000                 | 0.0001                             | 0.0011                             | 0.0004                         | 0.0000                                |
| 01-092       | 01-092-TP-1      | 290                          | 790                                 | 0.000                 | 0.0014                             | 0.0038                             | 0.0000                         | 0.0000                                |
| 01-094       | 01-094-WR-1      | 1130                         | 4500                                | 0.000                 | 33.6881                            | 37.1501                            | 0.3715                         | 0.3369                                |
| 01-112       | 01-112-WR-1      | 4160                         | 22410                               | 0.000                 | 1.0773                             | 1.1062                             | 0.0369                         | 0.0359                                |
| 01-143       | 01-143-WR-1      | 14000                        | 45000                               | 0.000                 | 107.1725                           | 117.2976                           | 1.1730                         | 1.0717                                |
| 01-143       | 01-143-WR-2      | 35000                        | 126000                              | 0.000                 | 70.2041                            | 76.2328                            | 2.5411                         | 2.3401                                |
| 01-144       | 01-144-WR-1      | 6700                         | 16200                               | 0.000                 | 2.2553                             | 2.3904                             | 0.0797                         | 0.0752                                |
| 01-144       | 01-144-TP-1      | 730                          | 4110                                | 0.000                 | 2.7533                             | 3.0145                             | 0.1005                         | 0.0918                                |
| 01-144       | 01-144-TP-2      | 730                          | 0                                   | 0.000                 | 4.6661                             | 5.1198                             | 0.0000                         | 0.0000                                |
| 01-169       | 01-169-WR-1      | 14285                        | 30857                               | 0.000                 | 0.1274                             | 0.1883                             | 0.0019                         | 0.0013                                |
| 01-169       | 01-169-WR-2      | 35715                        | 77143                               | 0.000                 | 24.5568                            | 27.0893                            | 0.0903                         | 0.0819                                |
| 01-169       | 01-169-GW-1      | 0                            | 0                                   | 0.334                 | 19.7000                            | 22.5000                            | 0.0000                         | 0.0000                                |
| 01-170       | 01-170-TP-2      | 11500                        | 0                                   | 0.000                 | 0.7841                             | 0.8057                             | 0.0000                         | 0.0000                                |
| 01-170       | 01-170-TP-4      | 52333                        | 0                                   | 0.000                 | 2.9386                             | 4.5044                             | 0.0000                         | 0.0000                                |
| 01-170       | 01-170-TP-5      | 15000                        | 15680                               | 0.000                 | 0.0783                             | 0.3389                             | 0.0034                         | 0.0008                                |
| 01-170       | 01-170-WR-1      | 11700                        | 37800                               | 0.000                 | 0.1623                             | 0.4339                             | 0.0043                         | 0.0016                                |
| 01-170       | 01-170-TP-1      | 34500                        | 11325                               | 0.000                 | 0.0755                             | 0.3148                             | 0.0010                         | 0.0003                                |
| 01-170       | 01-170-TP-3      | 263667                       | 105860                              | 0.000                 | 0.4849                             | 1.9594                             | 0.0196                         | 0.0048                                |
| 01-211       | 01-211-WR-1      | 200                          | 1890                                | 0.000                 | 0.2412                             | 0.3716                             | 0.0372                         | 0.0241                                |
| 01-211       | 01-211-WR-2      | 200                          | 1890                                | 0.000                 | 0.0151                             | 0.0205                             | 0.0020                         | 0.0015                                |
| 01-216       | 01-216-WR-1      | 13000                        | 36000                               | 0.000                 | 10.9119                            | 21.1890                            | 0.2119                         | 0.1091                                |
| 01-220       | 01-220-WR-1      | 11000                        | 10350                               | 0.000                 | 2.4858                             | 3.9169                             | 0.0392                         | 0.0249                                |
| 01-262       | 01-262-WR-1      | 2185                         | 2590                                | 0.000                 | 0.1672                             | 0.2120                             | 0.0021                         | 0.0017                                |
| 01-262       | 01-262-GW-1      | 0                            | 0                                   | 0.002                 | 0.1000                             | 0.1000                             | 0.0000                         | 0.0000                                |
| 01-270       | 01-270-WR-1      | 1070                         | 7740                                | 0.000                 | 1.8873                             | 2.0848                             | 0.0208                         | 0.0189                                |
| 01-270       | 01-270-GW-1      | 0                            | 0                                   | 0.003                 | 0.1000                             | 0.1000                             | 0.0000                         | 0.0000                                |
| 04-008       | 04-008-TP-1      | 1450                         | 4950                                | 0.000                 | 5.1831                             | 5.6875                             | 0.0569                         | 0.0518                                |
| 04-008       | 04-008-WR-1      | 36000                        | 98325                               | 0.000                 | 207.9062                           | 227.8892                           | 0.7596                         | 0.6930                                |
| 04-008       | 04-008-WR-2      | 1900                         | 64980                               | 0.000                 | 4.4681                             | 4.9330                             | 0.4933                         | 0.4468                                |
| 04-008       | 04-008-WR-3      | 37000                        | 52925                               | 0.000                 | 123.6988                           | 136.4987                           | 0.4550                         | 0.4123                                |
| 04-008       | 04-008-SW-3      | 0                            | 0                                   | 0.027                 | 0.7000                             | 0.7000                             | 0.0000                         | 0.0000                                |
| 04-009       | 04-009-WR-1      | 19500                        | 40500                               | 0.000                 | 2.9421                             | 3.6819                             | 0.0368                         | 0.0294                                |
| 04-009       | 04-009-TP-1      | 17000                        | 40500                               | 0.000                 | 3.6471                             | 4.3404                             | 0.0434                         | 0.0365                                |
| 04-009       | 04-009-TP-2      | 20000                        | 45000                               | 0.000                 | 2.2343                             | 2.5450                             | 0.0254                         | 0.0223                                |
| 04-012       | 04-012-WR-3      | 7000                         | 7650                                | 0.000                 | 69.1208                            | 73.2189                            | 0.2441                         | 0.2304                                |
| 04-012       | 04-012-TP-1      | 60                           | 3150                                | 0.000                 | 0.1604                             | 0.1728                             | 0.0576                         | 0.0535                                |
| 04-012       | 04-012-WR-1      | 30000                        | 46870                               | 0.000                 | 388.4346                           | 414.2678                           | 1.3809                         | 1.2948                                |
| 04-012       | 04-012-WR-2      | 27740                        | 54810                               | 0.000                 | 216.5973                           | 229.7195                           | 2.2972                         | 2.1660                                |
| 04-012       | 04-012-GW-1      | 0                            | 0                                   | 0.600                 | 225.8000                           | 233.5000                           | 0.0000                         | 0.0000                                |
| 04-013       | 04-013-WR-1      | 17000                        | 39600                               | 0.000                 | 73.9350                            | 76.6228                            | 0.7662                         | 0.7394                                |
| 04-013       | 04-013-LP-1      | 1300                         | 8000                                | 0.000                 | 3.1542                             | 3.2684                             | 0.0327                         | 0.0315                                |
| 04-014       | 04-014-WR-1      | 550                          | 3420                                | 0.000                 | 0.7845                             | 0.8130                             | 0.0271                         | 0.0261                                |
| 04-014       | 04-014-WR-2      | 2800                         | 5265                                | 0.000                 | 0.1294                             | 0.1321                             | 0.0013                         | 0.0013                                |

# WASTE CHARACTERISTICS SCORE WORKSHEET

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|--------------|------------------|------------------------------|-------------------------------------|-----------------------|------------------------------------|------------------------------------|--------------------------------|---------------------------------------|
| 04-014       | 04-014-WR-3      | 26500                        | 38790                               | 0.000                 | 45.6410                            | 46.6301                            | 0.4663                         | 0.4564                                |
| 04-014       | 04-014-TP-1      | 42000                        | 51975                               | 0.000                 | 528.2295                           | 544.7005                           | 1.8157                         | 1.7608                                |
| 04-014       | 04-014-SW-5      | 0                            | 0                                   | 0.022                 | 3.2000                             | 3.3000                             | 0.0000                         | 0.0000                                |
| 04-015       | 04-015-WR-1      | 14400                        | 34020                               | 0.000                 | 0.7379                             | 7.0691                             | 0.0707                         | 0.0074                                |
| 04-015       | 04-015-TP-1      | 9000                         | 34200                               | 0.000                 | 0.0610                             | 0.3285                             | 0.0109                         | 0.0020                                |
| 04-020       | 04-020-WR-1      | 52000                        | 63180                               | 0.000                 | 0.2557                             | 0.7271                             | 0.0024                         | 0.0009                                |
| 04-020       | 04-020-WR-2      | 19000                        | 30700                               | 0.000                 | 0.3228                             | 0.3479                             | 0.0035                         | 0.0032                                |
| 04-020       | 04-020-TP-1      | 220                          | 1710                                | 0.000                 | 0.0004                             | 0.0022                             | 0.0002                         | 0.0000                                |
| 04-121       | 04-121-TP-1      | 66000                        | 129600                              | 0.000                 | 5.2410                             | 6.1771                             | 0.2059                         | 0.1747                                |
| 04-121       | 04-121-TP2       | 78300                        | 158625                              | 0.000                 | 29.9712                            | 33.2768                            | 1.1092                         | 0.9990                                |
| 04-138       | 04-138-WR-1      | 5500                         | 15376                               | 0.000                 | 0.3613                             | 0.4475                             | 0.0149                         | 0.0120                                |
| 04-138       | 04-138-WR-2      | 2000                         | 2183                                | 0.000                 | 0.0759                             | 0.1345                             | 0.0013                         | 0.0008                                |
| 04-138       | 04-138-WR-3      | 4450                         | 12156                               | 0.000                 | 8.9011                             | 9.9816                             | 0.3327                         | 0.2967                                |
| 04-138       | 04-138-SW-1      | 0                            | 0                                   | 0.022                 | 2.0000                             | 2.8000                             | 0.0000                         | 0.0000                                |
| 04-144       | 04-144-WR-1      | 4360                         | 5886                                | 0.000                 | 0.2625                             | 0.3384                             | 0.0011                         | 0.0009                                |
| 04-144       | 04-144-SW-1      | 0                            | 0                                   | 0.022                 | 0.6000                             | 0.6000                             | 0.0000                         | 0.0000                                |
| 07-080       | 07-080-WR-1      | 2550                         | 7226                                | 0.000                 | 0.1167                             | 0.1293                             | 0.0013                         | 0.0012                                |
| 07-080       | 07-080-WR-2      | 2910                         | 9805                                | 0.000                 | 0.0284                             | 0.0316                             | 0.0003                         | 0.0003                                |
| 07-084       | 07-084-WR-1      | 18540                        | 30900                               | 0.000                 | 0.4126                             | 0.4461                             | 0.0045                         | 0.0041                                |
| 07-084       | 07-084-WR-2      | 80000                        | 54935                               | 0.000                 | 6.7902                             | 7.0405                             | 0.0235                         | 0.0226                                |
| 07-084       | 07-084-GW-1      | 0                            | 0                                   | 0.089                 | 2.1000                             | 2.2000                             | 0.0000                         | 0.0000                                |
| 07-084       | 07-084-GW-2      | 0                            | 0                                   | 0.033                 | 12.6000                            | 13.9000                            | 0.0000                         | 0.0000                                |
| 07-087       | 07-087-WR1       | 7100                         | 17100                               | 0.000                 | 29.2153                            | 32.1830                            | 1.0728                         | 0.9738                                |
| 07-087       | 07-087-WR2       | 2880                         | 19720                               | 0.000                 | 0.2656                             | 0.2958                             | 0.0296                         | 0.0266                                |
| 07-087       | 07-087-TP1       | 1200                         | 3040                                | 0.000                 | 0.8277                             | 0.9098                             | 0.0091                         | 0.0083                                |
| 07-087       | 07-087-GW-1      | 0                            | 0                                   | 0.089                 | 3.7000                             | 3.8000                             | 0.0000                         | 0.0000                                |
| 07-090       | BLOCK P TAILS    | 625000                       | 650000                              | 0.000                 | 1729.4998                          | 1876.8353                          | 6.2561                         | 5.7650                                |
| 07-094       | 07-094-WRD1      | 2800                         | 6450                                | 0.000                 | 9.1823                             | 10.0914                            | 0.1009                         | 0.0918                                |
| 07-094       | 07-094-WRD2      | 500                          | 1620                                | 0.000                 | 4.0566                             | 4.4578                             | 0.1486                         | 0.1352                                |
| 07-094       | 07-094-CONC      | 10                           | 180                                 | 0.000                 | 0.0360                             | 0.0393                             | 0.0039                         | 0.0036                                |
| 07-094       | 07-094-GW-1      | 0                            | 0                                   | 0.027                 | 1.6000                             | 1.9000                             | 0.0000                         | 0.0000                                |
| 07-100       | 07-100-WR1       | 200                          | 3520                                | 0.000                 | 0.1686                             | 0.1858                             | 0.0186                         | 0.0169                                |
| 07-100       | 07-100-WR4       | 390                          | 1150                                | 0.000                 | 0.0429                             | 0.0485                             | 0.0016                         | 0.0014                                |
| 07-100       | 07-100-GW-2      | 0                            | 0                                   | 0.011                 | 0.3000                             | 0.3000                             | 0.0000                         | 0.0000                                |
| 07-100       | 07-100-GW-3      | 0                            | 0                                   | 0.004                 | 0.0426                             | 0.0439                             | 0.0000                         | 0.0000                                |
| 07-103       | 07-103-LT-2      | 30000                        | 0                                   | 0.000                 | 129.9199                           | 143.9416                           | 0.0000                         | 0.0000                                |
| 07-103       | 07-103-LT-1      | 30000                        | 270000                              | 0.000                 | 218.8931                           | 242.3215                           | 8.0774                         | 7.2964                                |
| 07-103       | 07-103-UT1       | 25500                        | 223650                              | 0.000                 | 40.7399                            | 45.2968                            | 4.5297                         | 4.0740                                |
| 07-103       | 07-103-UT2       | 25500                        | 0                                   | 0.000                 | 31.6326                            | 35.1456                            | 0.0000                         | 0.0000                                |
| 07-110       | 07-110-WR5       | 2663                         | 13383                               | 0.000                 | 11.1286                            | 12.2579                            | 1.2258                         | 1.1129                                |
| 07-110       | 07-110-WR6       | 615                          | 1944                                | 0.000                 | 1.0610                             | 1.1740                             | 0.0391                         | 0.0354                                |
| 07-111       | 07-111-WR-1      | 8720                         | 24165                               | 0.000                 | 14.1238                            | 15.5231                            | 0.5174                         | 0.4708                                |
| 07-111       | 07-111-WR-2      | 285                          | 2835                                | 0.000                 | 0.5820                             | 0.6416                             | 0.0642                         | 0.0582                                |
| 07-111       | 07-111-GW-1      | 0                            | 0                                   | 0.082                 | 11.1000                            | 12.2000                            | 0.0000                         | 0.0000                                |
| 07-112       | 07-112-WR-1      | 2010                         | 8235                                | 0.000                 | 18.5465                            | 20.4135                            | 0.2041                         | 0.1855                                |
| 07-112       | 07-112-GW-1      | 0                            | 0                                   | 0.005                 | 0.6000                             | 0.6000                             | 0.0000                         | 0.0000                                |
| 07-113       | 07-113-WR1-AX    | 27                           | 382                                 | 0.000                 | 0.0354                             | 0.0393                             | 0.0039                         | 0.0035                                |
| 07-113       | 07-113-WR1-BX    | 28                           | 383                                 | 0.000                 | 0.0423                             | 0.0467                             | 0.0047                         | 0.0042                                |
| 07-120       | 07-120-WR-1      | 4200                         | 8100                                | 0.000                 | 5.5585                             | 6.1469                             | 0.0205                         | 0.0185                                |
| 07-120       | 07-120-TP-1      | 50                           | 5000                                | 0.000                 | 0.2215                             | 0.2438                             | 0.0813                         | 0.0738                                |
| 07-121       | 07-121-WR-1      | 3015                         | 9765                                | 0.000                 | 5.4661                             | 6.0521                             | 0.0202                         | 0.0182                                |
| 07-121       | 07-121-WR-5      | 3600                         | 11115                               | 0.000                 | 22.3487                            | 24.7423                            | 0.8247                         | 0.7450                                |
| 07-121       | 07-121-WR-6      | 3400                         | 8460                                | 0.000                 | 65.9435                            | 72.5734                            | 0.2419                         | 0.2198                                |
| 07-121       | 07-121-GW-1      | 0                            | 0                                   | 0.011                 | 6.0000                             | 6.9000                             | 0.0000                         | 0.0000                                |
| 07-129       | 07-129-WRD-1     | 1800                         | 9000                                | 0.000                 | 9.2220                             | 10.0529                            | 0.1005                         | 0.0922                                |
| 07-129       | 07-129-GW-1      | 0                            | 0                                   | 0.000                 | 0.0000                             | 0.0000                             | 0.0000                         | 0.0000                                |



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|--------------|------------------|------------------------------|-------------------------------------|-----------------------|------------------------------------|------------------------------------|--------------------------------|---------------------------------------|
| 07-129       | 07-129-GW-2      | 0                            | 0                                   | 0.000                 | 0.0000                             | 0.0000                             | 0.0000                         | 0.0000                                |
| 07-134       | 07-134-TP1-1     | 11250                        | 70000                               | 0.000                 | 51.7536                            | 56.9007                            | 0.5690                         | 0.5175                                |
| 07-134       | 07-134-TP1-2     | 11250                        | 0                                   | 0.000                 | 66.5312                            | 73.0878                            | 0.0000                         | 0.0000                                |
| 07-134       | 07-134-TP2       | 600                          | 4000                                | 0.000                 | 9.7530                             | 10.7316                            | 0.3577                         | 0.3251                                |
| 07-135       | 07-135-WR1       | 7600                         | 20475                               | 0.000                 | 93.9844                            | 103.5877                           | 3.4529                         | 3.1328                                |
| 07-135       | 07-135-WR2       | 4500                         | 23580                               | 0.000                 | 48.0209                            | 53.0300                            | 1.7677                         | 1.6007                                |
| 07-135       | 07-135-SW-1      | 0                            | 0                                   | 1.000                 | 917.9000                           | 1055.1000                          | 0.0000                         | 0.0000                                |
| 07-137       | 07-137-TP1       | 24675                        | 87188                               | 0.000                 | 79.9833                            | 88.5243                            | 0.8852                         | 0.7998                                |
| 07-137       | 07-137-TP2       | 24675                        | 87187                               | 0.000                 | 135.9512                           | 150.2860                           | 1.5029                         | 1.3595                                |
| 07-137       | 07-137-TP6       | 7000                         | 72000                               | 0.000                 | 6.9085                             | 7.6525                             | 0.2551                         | 0.2303                                |
| 07-138       | 07-138-WR1       | 4000                         | 15660                               | 0.000                 | 23.8580                            | 26.3768                            | 0.8792                         | 0.7953                                |
| 07-138       | 07-138-WR2       | 54000                        | 85500                               | 0.000                 | 231.2980                           | 255.8711                           | 0.8529                         | 0.7710                                |
| 07-138       | 07-138-TP1       | 24600                        | 52830                               | 0.000                 | 42.5990                            | 47.2042                            | 0.4720                         | 0.4260                                |
| 07-142       | 07-142-WR-AX     | 100                          | 2160                                | 0.000                 | 0.0003                             | 0.0012                             | 0.0001                         | 0.0000                                |
| 07-142       | 07-142-WR-BX     | 100                          | 2160                                | 0.000                 | 0.7942                             | 0.8786                             | 0.0879                         | 0.0794                                |
| 07-156       | 07-156-WR1       | 1100                         | 8640                                | 0.000                 | 0.4554                             | 0.4938                             | 0.0049                         | 0.0046                                |
| 07-156       | 07-156-WR2       | 700                          | 9000                                | 0.000                 | 0.8217                             | 0.8978                             | 0.0299                         | 0.0274                                |
| 07-156       | 07-156-WRD3      | 20000                        | 27900                               | 0.000                 | 7.6962                             | 8.2969                             | 0.0830                         | 0.0770                                |
| 07-156       | 07-156-WR-4      | 4000                         | 11160                               | 0.000                 | 3.2047                             | 3.4676                             | 0.1156                         | 0.1068                                |
| 07-156       | 07-156-TP-2      | 500                          | 1040                                | 0.000                 | 0.6966                             | 0.7607                             | 0.0254                         | 0.0232                                |
| 07-156       | 07-156-TP3A      | 600                          | 1260                                | 0.000                 | 0.0420                             | 0.0434                             | 0.0014                         | 0.0014                                |
| 07-156       | 07-156-TP3B      | 600                          | 0                                   | 0.000                 | 0.0976                             | 0.1043                             | 0.0000                         | 0.0000                                |
| 07-156       | 07-156-SW3       | 0                            | 0                                   | 0.060                 | 6.7000                             | 7.4000                             | 0.0000                         | 0.0000                                |
| 07-180       | 07-180-WR-1      | 455                          | 3330                                | 0.000                 | 0.1216                             | 0.1341                             | 0.0045                         | 0.0041                                |
| 12-003       | 12-003-WR-1      | 6500                         | 45760                               | 0.000                 | 0.1680                             | 0.2004                             | 0.0067                         | 0.0056                                |
| 12-003       | 12-003-TP-1      | 5700                         | 41800                               | 0.000                 | 0.3374                             | 0.3486                             | 0.0116                         | 0.0112                                |
| 12-003       | 12-003-GW-1      | 0                            | 0                                   | 0.027                 | 1.1000                             | 1.7000                             | 0.0000                         | 0.0000                                |
| 12-004       | 12-004-WR-1      | 27200                        | 71280                               | 0.000                 | 1.3370                             | 1.9163                             | 0.0192                         | 0.0134                                |
| 12-004       | 12-004-TP-1      | 4356                         | 11760                               | 0.000                 | 0.6564                             | 0.8630                             | 0.0288                         | 0.0219                                |
| 12-004       | 12-004-TP-3      | 5000                         | 2700                                | 0.000                 | 0.4361                             | 0.6781                             | 0.0023                         | 0.0015                                |
| 12-070       | 12-070-TP-1      | 7300                         | 31500                               | 0.000                 | 0.1235                             | 0.1366                             | 0.0046                         | 0.0041                                |
| 12-070       | 12-070-TP-2      | 1870                         | 12600                               | 0.000                 | 0.0001                             | 0.0002                             | 0.0000                         | 0.0000                                |
| 14-010       | 14-010-WR-1      | 3800                         | 6035                                | 0.000                 | 0.8279                             | 0.8731                             | 0.0029                         | 0.0028                                |
| 14-010       | 14-010-GW-1      | 0                            | 0                                   | 0.003                 | 0.1000                             | 0.1000                             | 0.0000                         | 0.0000                                |
| 14-017       | 14-017-TP-2      | 10                           | 0                                   | 0.000                 | 0.0081                             | 0.0088                             | 0.0000                         | 0.0000                                |
| 14-017       | 14-017-TP-1      | 1210                         | 1780                                | 0.000                 | 0.1022                             | 0.1051                             | 0.0011                         | 0.0010                                |
| 14-017       | 14-017-WR-1      | 105                          | 1160                                | 0.000                 | 0.1290                             | 0.1415                             | 0.0141                         | 0.0129                                |
| 14-017       | 14-017-WR-2      | 2830                         | 1890                                | 0.000                 | 1.3044                             | 1.4653                             | 0.0147                         | 0.0130                                |
| 15-012       | 15-012-TP-1      | 525                          | 4075                                | 0.000                 | 1.0809                             | 1.1836                             | 0.0395                         | 0.0360                                |
| 15-012       | 15-012-WR-1      | 19000                        | 67500                               | 0.000                 | 38.7106                            | 42.2938                            | 0.4229                         | 0.3871                                |
| 15-012       | 15-012-WR-2      | 50500                        | 262800                              | 0.000                 | 521.0536                           | 570.9257                           | 19.0309                        | 17.3685                               |
| 15-012       | 15-012-WR-3      | 18550                        | 97650                               | 0.000                 | 18.9089                            | 20.5988                            | 0.2060                         | 0.1891                                |
| 15-012       | 15-012-WR-4      | 1530                         | 6550                                | 0.000                 | 25.2192                            | 27.5189                            | 0.2752                         | 0.2522                                |
| 15-012       | 15-012-GW-1      | 0                            | 0                                   | 0.002                 | 2.9000                             | 3.3000                             | 0.0000                         | 0.0000                                |
| 15-012       | 15-012-GW-2      | 0                            | 0                                   | 0.056                 | 2.9000                             | 3.5000                             | 0.0000                         | 0.0000                                |
| 16-013       | 16-013-WR-1      | 7150                         | 12199                               | 0.000                 | 0.0645                             | 0.1165                             | 0.0039                         | 0.0022                                |
| 16-015       | 16-015-WR-1      | 5000                         | 20250                               | 0.000                 | 0.0043                             | 0.0043                             | 0.0001                         | 0.0001                                |
| 16-018       | 16-018-WR-1      | 4400                         | 6480                                | 0.000                 | 150.0000                           | 150.0000                           | 0.5000                         | 0.5000                                |
| 16-018       | 16-018-WR-2      | 15                           | 125                                 | 0.000                 | 0.5000                             | 0.5000                             | 0.0500                         | 0.0500                                |
| 20-002       | 20-002-WR-1      | 22000                        | 18000                               | 0.000                 | 86.5809                            | 87.1822                            | 0.8718                         | 0.8658                                |
| 20-002       | 20-002-WR-2      | 40000                        | 99000                               | 0.000                 | 99.5276                            | 101.1079                           | 0.3370                         | 0.3318                                |
| 20-002       | 20-002-TP-1      | 40                           | 1800                                | 0.000                 | 0.1206                             | 0.1229                             | 0.0410                         | 0.0402                                |
| 20-003       | 20-003-TP1A      | 63000                        | 55250                               | 0.000                 | 161.8390                           | 166.8285                           | 0.5561                         | 0.5395                                |
| 20-003       | 20-003-TP1B      | 63000                        | 55250                               | 0.000                 | 103.6276                           | 105.4985                           | 0.3517                         | 0.3454                                |
| 20-003       | 20-003-TP2A      | 101400                       | 36000                               | 0.000                 | 283.9522                           | 290.4376                           | 0.2904                         | 0.2840                                |
| 20-003       | 20-003-TP2B-A    | 33800                        | 36000                               | 0.000                 | 58.2514                            | 59.3538                            | 0.1978                         | 0.1942                                |



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|--------------|------------------|------------------------------|-------------------------------------|-----------------------|------------------------------------|------------------------------------|--------------------------------|---------------------------------------|
| 20-003       | 20-003-TP2B-B    | 33800                        | 0                                   | 0.000                 | 121.9073                           | 125.1995                           | 0.0000                         | 0.0000                                |
| 20-004       | 20-004-WR-1      | 5000                         | 24858                               | 0.000                 | 14.4217                            | 15.8647                            | 0.5288                         | 0.4807                                |
| 20-004       | 20-004-WR-3      | 2000                         | 16560                               | 0.000                 | 62.1415                            | 68.3499                            | 6.8350                         | 6.2141                                |
| 20-004       | 20-004-WR-4      | 1000                         | 2520                                | 0.000                 | 0.5450                             | 0.7150                             | 0.0072                         | 0.0055                                |
| 20-004       | 20-004-TP-1      | 4000                         | 17820                               | 0.000                 | 21.6000                            | 23.7308                            | 0.7910                         | 0.7200                                |
| 20-004       | 20-004-TP-2      | 11000                        | 44370                               | 0.000                 | 23.9121                            | 26.9185                            | 0.2692                         | 0.2391                                |
| 20-004       | 20-004-TP-3      | 8000                         | 17820                               | 0.000                 | 3.1194                             | 3.6342                             | 0.1211                         | 0.1040                                |
| 20-004       | 20-004-GW-1      | 0                            | 0                                   | 0.045                 | 0.6000                             | 0.7000                             | 0.0000                         | 0.0000                                |
| 20-005       | 20-005-WR-1      | 27700                        | 45900                               | 0.000                 | 8.4381                             | 9.3206                             | 0.0932                         | 0.0844                                |
| 20-005       | 20-005-WR-2      | 4800                         | 22500                               | 0.000                 | 6.2602                             | 6.6479                             | 0.2216                         | 0.2087                                |
| 20-005       | 20-005-WR-3      | 17000                        | 31500                               | 0.000                 | 21.4425                            | 23.1183                            | 0.2312                         | 0.2144                                |
| 20-009       | 20-009-TP-1      | 69500                        | 748800                              | 0.000                 | 565.7537                           | 621.5269                           | 20.7176                        | 18.8585                               |
| 20-012       | 20-012-TP-1      | 475                          | 16335                               | 0.000                 | 1.1157                             | 1.2103                             | 0.4034                         | 0.3719                                |
| 20-012       | 20-012-TP-2      | 970                          | 51300                               | 0.000                 | 1.0751                             | 1.1611                             | 0.3870                         | 0.3584                                |
| 20-012       | 20-012-WR-1      | 3200                         | 3870                                | 0.000                 | 24.3328                            | 26.5414                            | 0.0885                         | 0.0811                                |
| 20-018       | 20-018-WR-1      | 22000                        | 45900                               | 0.000                 | 0.0247                             | 0.1524                             | 0.0015                         | 0.0002                                |
| 20-018       | 20-018-TP-1      | 2800                         | 5130                                | 0.000                 | 0.7032                             | 0.7468                             | 0.0075                         | 0.0070                                |
| 20-018       | 20-018-SW-2      | 0                            | 0                                   | 0.029                 | 0.5000                             | 0.5000                             | 0.0000                         | 0.0000                                |
| 20-019       | 20-019-WR-1      | 218000                       | 29580                               | 0.000                 | 342.4138                           | 374.4676                           | 0.3745                         | 0.3424                                |
| 20-019       | 20-019-WR-2      | 324000                       | 34020                               | 0.000                 | 428.2296                           | 464.2266                           | 0.1547                         | 0.1427                                |
| 20-023       | 20-023-WR-2      | 800                          | 3150                                | 0.000                 | 0.1048                             | 0.1127                             | 0.0038                         | 0.0035                                |
| 20-023       | 20-023-WR-3      | 350                          | 1620                                | 0.000                 | 0.0417                             | 0.0573                             | 0.0019                         | 0.0014                                |
| 20-023       | 20-023-WR-1      | 5675                         | 53100                               | 0.000                 | 0.4209                             | 0.5060                             | 0.0169                         | 0.0140                                |
| 20-023       | 20-023-WR-4      | 2980                         | 10125                               | 0.000                 | 0.0975                             | 0.1775                             | 0.0178                         | 0.0098                                |
| 20-023       | 20-023-WR-5      | 4400                         | 27000                               | 0.000                 | 0.2645                             | 0.3544                             | 0.0118                         | 0.0088                                |
| 20-023       | 20-023-GW-1      | 0                            | 0                                   | 0.002                 | 0.4000                             | 0.5000                             | 0.0000                         | 0.0000                                |
| 20-023       | 20-023-GW-2      | 0                            | 0                                   | 0.001                 | 0.0238                             | 0.0256                             | 0.0000                         | 0.0000                                |
| 20-025       | 20-025-WR-2      | 7650                         | 25200                               | 0.000                 | 19.8589                            | 21.5940                            | 0.7198                         | 0.6620                                |
| 20-025       | 20-025-WR-3      | 16500                        | 40500                               | 0.000                 | 28.3599                            | 30.7054                            | 0.3071                         | 0.2836                                |
| 20-025       | 20-025-WR-5      | 14000                        | 23400                               | 0.000                 | 39.3073                            | 42.8803                            | 0.4288                         | 0.3931                                |
| 20-025       | 20-025-TP-1      | 4800                         | 32000                               | 0.000                 | 21.3839                            | 23.2381                            | 0.7746                         | 0.7128                                |
| 20-027       | 20-027-WR-2      | 650                          | 1575                                | 0.000                 | 3.0839                             | 3.3380                             | 0.1113                         | 0.1028                                |
| 20-027       | 20-027-WR-1      | 2250                         | 4770                                | 0.000                 | 3.7680                             | 4.0876                             | 0.0409                         | 0.0377                                |
| 20-062       | 20-062-WR-3      | 5000                         | 10000                               | 0.000                 | 0.0775                             | 0.1007                             | 0.0034                         | 0.0026                                |
| 20-062       | 20-062-WR-1      | 1440                         | 24950                               | 0.000                 | 1.5235                             | 1.5512                             | 0.1551                         | 0.1524                                |
| 20-062       | 20-062-WR-2      | 16700                        | 45990                               | 0.000                 | 40.2163                            | 44.0657                            | 0.4407                         | 0.4022                                |
| 20-062       | 20-062-TP-1      | 35800                        | 130500                              | 0.000                 | 32.6838                            | 35.6620                            | 1.1887                         | 1.0895                                |
| 20-062       | 20-062-TP-2      | 57200                        | 0                                   | 0.000                 | 96.6535                            | 105.8838                           | 0.0000                         | 0.0000                                |
| 20-062       | 20-062-SL-1      | 1750                         | 23400                               | 0.000                 | 2.2766                             | 2.4109                             | 0.2411                         | 0.2277                                |
| 20-065       | 20-065-WR-2      | 8                            | 63                                  | 0.000                 | 0.0002                             | 0.0004                             | 0.0001                         | 0.0001                                |
| 20-065       | 20-065-WR-1      | 14015                        | 37917                               | 0.000                 | 0.3209                             | 0.4392                             | 0.0044                         | 0.0032                                |
| 20-065       | 20-065-GW-1      | 0                            | 0                                   | 0.011                 | 0.2000                             | 0.2000                             | 0.0000                         | 0.0000                                |
| 20-110       | 20-110-TP-2      | 280                          | 1260                                | 0.000                 | 5.6482                             | 5.6976                             | 0.5698                         | 0.5648                                |
| 20-110       | 20-110-WR-1      | 61000                        | 256500                              | 0.000                 | 111.8267                           | 113.1338                           | 3.7711                         | 3.7276                                |
| 20-111       | 20-111-WR-1      | 98000                        | 121500                              | 0.000                 | 15.8719                            | 16.9852                            | 0.5662                         | 0.5291                                |
| 20-111       | 20-111-WR-2      | 8300                         | 21690                               | 0.000                 | 4.8426                             | 5.2669                             | 0.1756                         | 0.1614                                |
| 20-175       | 20-175-WR-1      | 15000                        | 40500                               | 0.000                 | 6.5892                             | 7.0693                             | 0.0707                         | 0.0659                                |
| 20-175       | 20-175-TP-1      | 2500                         | 90000                               | 0.000                 | 1.2434                             | 1.3338                             | 0.1334                         | 0.1243                                |
| 20-180       | 20-180-WR-1      | 6700                         | 32220                               | 0.000                 | 0.1593                             | 0.1756                             | 0.0059                         | 0.0053                                |
| 20-180       | 20-180-TP-1      | 5600                         | 7650                                | 0.000                 | 0.2711                             | 0.2993                             | 0.0010                         | 0.0009                                |
| 20-186       | 20-186-WR-1      | 13800                        | 38655                               | 0.000                 | 6.0719                             | 6.5171                             | 0.0652                         | 0.0607                                |
| 20-186       | 20-186-WR-4      | 12000                        | 38925                               | 0.000                 | 8.4227                             | 8.9640                             | 0.0896                         | 0.0842                                |
| 20-186       | 20-186-SP-1      | 235                          | 28035                               | 0.000                 | 0.0669                             | 0.0685                             | 0.0685                         | 0.0669                                |
| 20-186       | 20-186-GW-1      | 0                            | 0                                   | 0.111                 | 1.8000                             | 1.9000                             | 0.0000                         | 0.0000                                |
| 20-191       | 20-191-WR1X      | 700                          | 1260                                | 0.000                 | 0.2017                             | 0.2195                             | 0.0073                         | 0.0067                                |
| 20-194       | 20-194-WR-1      | 2300                         | 7157                                | 0.000                 | 1.0690                             | 1.1264                             | 0.0113                         | 0.0107                                |

# WASTE CHARACTERISTICS SCORE WORKSHEET

| PA<br>NUMBER | SAMPLE<br>NUMBER | WASTE<br>VOLUME<br>(CU. YD.) | UNCOV<br>WASTE<br>AREA<br>(SQ. FT.) | ADIT<br>FLOW<br>(CFS) | GRND W.<br>WASTE<br>CHAR.<br>SCORE | SURF W.<br>WASTE<br>CHAR.<br>SCORE | AIR<br>WASTE<br>CHAR.<br>SCORE | DIR. CONT.<br>WASTE<br>CHAR.<br>SCORE |
|--------------|------------------|------------------------------|-------------------------------------|-----------------------|------------------------------------|------------------------------------|--------------------------------|---------------------------------------|
| 20-194       | 20-194-SW-1      | 0                            | 0                                   | 0.001                 | 0.0198                             | 0.0206                             | 0.0000                         | 0.0000                                |
| 20-209       | 20-209-WR-2      | 1300                         | 5850                                | 0.000                 | 2.3998                             | 2.5046                             | 0.0250                         | 0.0240                                |
| 20-209       | 20-209-TP-1      | 10550                        | 48600                               | 0.000                 | 47.4269                            | 47.9177                            | 0.4792                         | 0.4743                                |
| 20-209       | 20-209-TP-2      | 0                            | 0                                   | 0.000                 | 0.0000                             | 0.0000                             | 0.0000                         | 0.0000                                |
| 20-209       | 20-209-WR-1      | 7100                         | 37800                               | 0.000                 | 7.4361                             | 7.6438                             | 0.2548                         | 0.2479                                |
| 20-209       | 20-209-SW-1      | 0                            | 0                                   | 0.073                 | 72.7000                            | 73.2000                            | 0.0000                         | 0.0000                                |
| 22-001       | 22-001-WR-1      | 130000                       | 105000                              | 0.000                 | 355.5399                           | 390.5160                           | 3.9052                         | 3.5554                                |
| 22-001       | 22-001-WR-2      | 11250                        | 30150                               | 0.000                 | 151.2434                           | 165.9045                           | 1.6590                         | 1.5124                                |
| 22-001       | 22-001-WR-3      | 53000                        | 77500                               | 0.000                 | 83.6222                            | 91.5975                            | 0.3053                         | 0.2787                                |
| 22-002       | 22-002-WR-1      | 3500                         | 9855                                | 0.000                 | 23.9826                            | 26.4221                            | 0.0881                         | 0.0799                                |
| 22-002       | 22-002-WR-2      | 18400                        | 0                                   | 0.000                 | 0.0032                             | 0.0829                             | 0.0000                         | 0.0000                                |
| 22-002       | 22-002-TP-2      | 148                          | 4095                                | 0.000                 | 0.0002                             | 0.0023                             | 0.0002                         | 0.0000                                |
| 22-002       | 22-002-TP-1      | 116500                       | 104205                              | 0.000                 | 15.8893                            | 23.9666                            | 0.2397                         | 0.1589                                |
| 22-003       | 22-003-WR-1      | 58410                        | 75690                               | 0.000                 | 158.9913                           | 174.0317                           | 0.5801                         | 0.5300                                |
| 22-003       | 22-003-WR-2      | 12140                        | 30690                               | 0.000                 | 0.7305                             | 0.7917                             | 0.0079                         | 0.0073                                |
| 22-003       | 22-003-SW-1      | 0                            | 0                                   | 0.064                 | 6.9000                             | 8.1000                             | 0.0000                         | 0.0000                                |
| 22-004       | 22-004-TP-1      | 500000                       | 1110000                             | 0.000                 | 2504.1369                          | 2723.6094                          | 90.7870                        | 83.4712                               |
| 22-004       | 22-004-TP-2      | 200000                       | 0                                   | 0.000                 | 1614.8703                          | 1769.6622                          | 0.0000                         | 0.0000                                |
| 22-005       | 22-005-TP-1      | 10                           | 210                                 | 0.000                 | 0.0581                             | 0.0583                             | 0.0058                         | 0.0058                                |
| 22-005       | 22-005-WR-1      | 27000                        | 87300                               | 0.000                 | 119.2990                           | 130.4309                           | 1.3043                         | 1.1930                                |
| 22-005       | 22-005-WR-2      | 2200                         | 8100                                | 0.000                 | 4.6584                             | 5.1053                             | 0.0511                         | 0.0466                                |
| 22-005       | 22-005-WR-3      | 120                          | 1080                                | 0.000                 | 0.6927                             | 0.7589                             | 0.0759                         | 0.0693                                |
| 22-005       | 22-005-TP-2      | 10000                        | 128000                              | 0.000                 | 15.5402                            | 15.5559                            | 1.5556                         | 1.5540                                |
| 22-007       | 22-007-TP-1      | 71200                        | 76680                               | 0.000                 | 433.5456                           | 452.1384                           | 1.5071                         | 1.4452                                |
| 22-007       | 22-007-TP-2      | 15000                        | 36000                               | 0.000                 | 147.7293                           | 152.5642                           | 1.5256                         | 1.4773                                |
| 22-007       | 22-007-WR-1      | 30550                        | 61650                               | 0.000                 | 123.8552                           | 129.6815                           | 0.4323                         | 0.4129                                |
| 22-007       | 22-007-WR-2      | 5450                         | 11070                               | 0.000                 | 21.1979                            | 22.4178                            | 0.7473                         | 0.7066                                |
| 22-007       | 22-007-GW-1      | 0                            | 0                                   | 0.044                 | 6.8000                             | 6.9000                             | 0.0000                         | 0.0000                                |
| 22-007       | 22-007-GW-2      | 0                            | 0                                   | 0.013                 | 0.7000                             | 0.8000                             | 0.0000                         | 0.0000                                |
| 22-008       | 22-008-WR-1      | 13266                        | 44100                               | 0.000                 | 218.5230                           | 222.3046                           | 2.2230                         | 2.1852                                |
| 22-008       | 22-008-WR-2      | 18200                        | 39600                               | 0.000                 | 129.4845                           | 140.8083                           | 1.4081                         | 1.2948                                |
| 22-008       | 22-008-TP-1      | 1800                         | 8100                                | 0.000                 | 5.8568                             | 6.1912                             | 0.0619                         | 0.0586                                |
| 22-008       | 22-008-TP-2      | 1600                         | 10800                               | 0.000                 | 7.3425                             | 7.7308                             | 0.7731                         | 0.7342                                |
| 22-008       | 22-008-TP-3      | 800                          | 0                                   | 0.000                 | 2.8858                             | 3.0412                             | 0.0000                         | 0.0000                                |
| 22-008       | 22-008-GW-1      | 0                            | 0                                   | 0.016                 | 145.6000                           | 153.2000                           | 0.0000                         | 0.0000                                |
| 22-009       | 22-009-TP-1      | 36545                        | 121500                              | 0.000                 | 183.7141                           | 189.2432                           | 6.3081                         | 6.1238                                |
| 22-009       | 22-009-TP-2      | 358500                       | 387000                              | 0.000                 | 2118.1887                          | 2204.1426                          | 7.3471                         | 7.0606                                |
| 22-009       | 22-009-TP-3      | 97455                        | 121500                              | 0.000                 | 164.8064                           | 172.3518                           | 5.7451                         | 5.4935                                |
| 22-009       | 22-009-WR-1      | 213000                       | 207000                              | 0.000                 | 518.5804                           | 557.9142                           | 5.5791                         | 5.1858                                |
| 22-009       | 22-009-WR-2      | 870                          | 8370                                | 0.000                 | 1.1015                             | 1.1828                             | 0.0394                         | 0.0367                                |
| 22-027       | 22-027-WR-1      | 23000                        | 21330                               | 0.000                 | 507.2783                           | 549.0765                           | 5.4908                         | 5.0728                                |
| 22-029       | 22-029-WR-1      | 72100                        | 100350                              | 0.000                 | 23.2605                            | 25.4072                            | 0.8469                         | 0.7754                                |
| 22-032       | 22-032-WR-1      | 148                          | 618                                 | 0.000                 | 0.0109                             | 0.0122                             | 0.0001                         | 0.0001                                |
| 22-032       | 22-032-WR-2      | 4000                         | 10620                               | 0.000                 | 1.0156                             | 1.1284                             | 0.0376                         | 0.0339                                |
| 22-036       | 22-036-WR-1      | 868                          | 6989                                | 0.000                 | 3.7410                             | 4.1060                             | 0.1369                         | 0.1247                                |
| 22-036       | 22-036-WR-2      | 867                          | 6988                                | 0.000                 | 0.7343                             | 0.8101                             | 0.0270                         | 0.0245                                |
| 22-036       | 22-036-TP-1      | 9500                         | 57000                               | 0.000                 | 0.3619                             | 0.3948                             | 0.0132                         | 0.0121                                |
| 22-036       | 22-036-TP-2      | 9500                         | 28500                               | 0.000                 | 18.6778                            | 19.7687                            | 0.6590                         | 0.6226                                |
| 22-039       | 22-074-PL12X     | 22000                        | 118980                              | 0.000                 | 0.0060                             | 0.0621                             | 0.0062                         | 0.0006                                |
| 22-046       | 22-046-WR-1      | 3334                         | 18000                               | 0.000                 | 19.3462                            | 19.6459                            | 0.6549                         | 0.6449                                |
| 22-046       | 22-046-WR-2      | 5466                         | 26820                               | 0.000                 | 16.1295                            | 16.8705                            | 0.5624                         | 0.5376                                |
| 22-046       | 22-046-WR-3      | 5100                         | 21600                               | 0.000                 | 18.3035                            | 18.8847                            | 0.6295                         | 0.6101                                |
| 22-046       | 22-046-WR-4      | 3800                         | 13500                               | 0.000                 | 79.4194                            | 80.3762                            | 2.6792                         | 2.6473                                |
| 22-049       | 22-049-WR-1      | 430                          | 1530                                | 0.000                 | 1.2666                             | 1.3940                             | 0.0465                         | 0.0422                                |
| 22-049       | 22-049-WR-2      | 5130                         | 7085                                | 0.000                 | 0.1641                             | 0.1817                             | 0.0006                         | 0.0005                                |
| 22-054       | 22-046-WR-5      | 1700                         | 18000                               | 0.000                 | 3.3923                             | 3.4920                             | 0.3492                         | 0.3392                                |



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|--------------|------------------|------------------------------|-------------------------------------|-----------------------|------------------------------------|------------------------------------|--------------------------------|---------------------------------------|
| 22-054       | 22-046-SW-7      | 0                            | 0                                   | 0.045                 | 2.2000                             | 2.3000                             | 0.0000                         | 0.0000                                |
| 22-072       | 22-072-WR-1      | 6130                         | 19327                               | 0.000                 | 6.8834                             | 7.4063                             | 0.2469                         | 0.2294                                |
| 22-072       | 22-072-TP-4      | 0                            | 0                                   | 0.000                 | 0.0000                             | 0.0000                             | 0.0000                         | 0.0000                                |
| 22-072       | 22-072-TP-1      | 8894                         | 84038                               | 0.000                 | 100.0954                           | 104.4058                           | 3.4802                         | 3.3365                                |
| 22-072       | 22-072-TP-2      | 5928                         | 0                                   | 0.000                 | 1.0668                             | 1.1249                             | 0.0000                         | 0.0000                                |
| 22-072       | 22-072-TP-3      | 5928                         | 84037                               | 0.000                 | 2.1822                             | 2.2137                             | 0.0738                         | 0.0727                                |
| 22-073       | 22-073-WR-5      | 52857                        | 28369                               | 0.000                 | 308.1753                           | 319.1783                           | 1.0639                         | 1.0273                                |
| 22-073       | 22-073-WR-1      | 4675                         | 42075                               | 0.000                 | 9.6504                             | 9.9713                             | 0.3324                         | 0.3217                                |
| 22-073       | 22-073-WR-2      | 4675                         | 42075                               | 0.000                 | 2.6680                             | 2.8793                             | 0.0960                         | 0.0889                                |
| 22-073       | 22-073-WR-3      | 13000                        | 62010                               | 0.000                 | 38.6917                            | 42.2771                            | 0.4228                         | 0.3869                                |
| 22-073       | 22-073-WR-4      | 10700                        | 59490                               | 0.000                 | 70.9617                            | 74.3588                            | 0.7436                         | 0.7096                                |
| 22-073       | 22-073-WR-6      | 122428                       | 113477                              | 0.000                 | 45.2623                            | 46.6767                            | 0.4668                         | 0.4526                                |
| 22-073       | 22-073-WR-7      | 105715                       | 56738                               | 0.000                 | 53.7000                            | 56.5550                            | 0.0566                         | 0.0537                                |
| 22-073       | 22-073-SW-4      | 0                            | 0                                   | 0.056                 | 350.2000                           | 368.7000                           | 0.0000                         | 0.0000                                |
| 22-074       | 22-074-WR-1      | 11465                        | 47187                               | 0.000                 | 67.1823                            | 68.2906                            | 0.6829                         | 0.6718                                |
| 22-074       | 22-074-WR-2      | 11465                        | 47187                               | 0.000                 | 259.9880                           | 263.7474                           | 2.6375                         | 2.5999                                |
| 22-074       | 22-074-SW-4      | 0                            | 0                                   | 0.001                 | 5.1000                             | 5.2000                             | 0.0000                         | 0.0000                                |
| 22-075       | 22-075-WR-2      | 2190                         | 25200                               | 0.000                 | 20.5951                            | 21.2037                            | 2.1204                         | 2.0595                                |
| 22-075       | 22-075-WR-1      | 90000                        | 96300                               | 0.000                 | 48.5541                            | 52.5643                            | 0.1752                         | 0.1618                                |
| 22-075       | 22-075-TP-1      | 11000                        | 149400                              | 0.000                 | 26.2136                            | 27.6484                            | 2.7648                         | 2.6214                                |
| 22-075       | 22-075-GW-1      | 0                            | 0                                   | 0.011                 | 0.4000                             | 0.4000                             | 0.0000                         | 0.0000                                |
| 22-077       | 22-077-WR-1      | 28800                        | 37485                               | 0.000                 | 1.1912                             | 1.3857                             | 0.0139                         | 0.0119                                |
| 22-077       | 22-077-TP-1      | 2400                         | 26460                               | 0.000                 | 4.3626                             | 4.5824                             | 0.4582                         | 0.4363                                |
| 22-077       | 22-077-TP-2      | 4800                         | 0                                   | 0.000                 | 1.6965                             | 1.8550                             | 0.0000                         | 0.0000                                |
| 22-102       | 22-102-WR-1      | 13335                        | 43484                               | 0.000                 | 6.7041                             | 7.4098                             | 0.0741                         | 0.0670                                |
| 22-102       | 22-102-WR-2      | 12665                        | 43216                               | 0.000                 | 77.0324                            | 84.6259                            | 0.8463                         | 0.7703                                |
| 22-102       | 22-102-GW-1      | 0                            | 0                                   | 0.000                 | 0.0000                             | 0.0000                             | 0.0000                         | 0.0000                                |
| 22-102       | 22-102-GW-2      | 0                            | 0                                   | 0.013                 | 0.2000                             | 0.2000                             | 0.0000                         | 0.0000                                |
| 22-111       | 22-111-WR-1      | 80000                        | 181800                              | 0.000                 | 42.9689                            | 45.1580                            | 1.5053                         | 1.4323                                |
| 22-244       | 22-244-TA1       | 3333                         | 22500                               | 0.000                 | 40.7083                            | 43.6043                            | 1.4535                         | 1.3569                                |
| 22-244       | 22-244-TA2       | 3334                         | 0                                   | 0.000                 | 69.6652                            | 74.0991                            | 0.0000                         | 0.0000                                |
| 22-244       | 22-244-WR-1      | 30                           | 1800                                | 0.000                 | 0.4935                             | 0.5400                             | 0.1800                         | 0.1645                                |
| 22-244       | 22-244-WR-3      | 2460                         | 15120                               | 0.000                 | 9.9559                             | 10.7270                            | 1.0727                         | 0.9956                                |
| 22-244       | 22-244-TA3       | 3333                         | 0                                   | 0.000                 | 58.2472                            | 61.4657                            | 0.0000                         | 0.0000                                |
| 22-245       | 22-245-WR-1      | 240                          | 1620                                | 0.000                 | 0.6101                             | 0.6488                             | 0.0649                         | 0.0610                                |
| 22-245       | 22-245-WR-2      | 370                          | 1260                                | 0.000                 | 3.1500                             | 3.3137                             | 0.1105                         | 0.1050                                |
| 22-284       | 22-284-WR-1      | 5170                         | 13422                               | 0.000                 | 71.1669                            | 78.2854                            | 2.6095                         | 2.3722                                |
| 22-284       | 22-284-WR-2      | 2150                         | 7152                                | 0.000                 | 1.2915                             | 1.4208                             | 0.0142                         | 0.0129                                |
| 22-296       | 22-296-TP-1      | 15333                        | 47916                               | 0.000                 | 1.7656                             | 1.8849                             | 0.0188                         | 0.0177                                |
| 22-296       | 22-296-TP-2      | 7667                         | 47916                               | 0.000                 | 7.4603                             | 7.6696                             | 0.2557                         | 0.2487                                |
| 22-301       | 22-301-WR-1      | 580                          | 1328                                | 0.000                 | 0.1415                             | 0.1548                             | 0.0052                         | 0.0047                                |
| 22-336       | 22-336-WR-1      | 14650                        | 56430                               | 0.000                 | 4.8498                             | 4.9246                             | 0.0492                         | 0.0485                                |
| 22-336       | 22-336-WR-2      | 14000                        | 56686                               | 0.000                 | 4.6086                             | 4.9502                             | 0.0495                         | 0.0461                                |
| 22-336       | 22-336-WR-3      | 3800                         | 22226                               | 0.000                 | 0.0894                             | 0.1012                             | 0.0034                         | 0.0030                                |
| 22-336       | 22-336-SW-3      | 0                            | 0                                   | 0.016                 | 0.9000                             | 1.4000                             | 0.0000                         | 0.0000                                |
| 22-358       | 22-358-WR-3      | 50                           | 450                                 | 0.000                 | 1.0629                             | 1.1591                             | 0.0386                         | 0.0354                                |
| 22-358       | 22-358-WR-1      | 0                            | 0                                   | 0.000                 | 0.0000                             | 0.0000                             | 0.0000                         | 0.0000                                |
| 22-358       | 22-358-WR-2      | 37                           | 540                                 | 0.000                 | 0.2881                             | 0.3165                             | 0.0105                         | 0.0096                                |
| 23-001       | BLOCK P MINE     | 125000                       | 180000                              | 0.000                 | 1044.0000                          | 1145.7958                          | 11.4580                        | 10.4400                               |
| 23-022       | 23-022-WR2       | 350                          | 6885                                | 0.000                 | 0.1690                             | 0.1861                             | 0.0062                         | 0.0056                                |
| 23-022       | 23-022-WR4       | 390                          | 2700                                | 0.000                 | 3.5561                             | 3.9061                             | 0.1302                         | 0.1185                                |
| 23-027       | 23-027-TP-1      | 450                          | 12150                               | 0.000                 | 0.0113                             | 0.0113                             | 0.0038                         | 0.0038                                |
| 23-035       | 23-035-TP1B      | 450                          | 0                                   | 0.000                 | 3.7979                             | 4.0919                             | 0.0000                         | 0.0000                                |
| 23-035       | 23-035-TP1A      | 300                          | 8100                                | 0.000                 | 5.2790                             | 5.7848                             | 0.1928                         | 0.1760                                |
| 23-042       | 23-042-WR1       | 4500                         | 11925                               | 0.000                 | 2.2722                             | 2.4545                             | 0.0818                         | 0.0757                                |
| 23-042       | 23-042-SW-1      | 0                            | 0                                   | 0.017                 | 0.7000                             | 0.7000                             | 0.0000                         | 0.0000                                |

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|--------------|------------------|------------------------------|-------------------------------------|-----------------------|------------------------------------|------------------------------------|--------------------------------|---------------------------------------|
| 23-045       | 23-045-WR-2      | 2320                         | 14085                               | 0.000                 | 8.4438                             | 9.2768                             | 0.9277                         | 0.8444                                |
| 23-045       | 23-045-WR-4      | 17400                        | 34425                               | 0.000                 | 142.5406                           | 156.5884                           | 1.5659                         | 1.4254                                |
| 23-046       | 23-046-WR-2      | 50000                        | 109800                              | 0.000                 | 758.9495                           | 833.6969                           | 27.7899                        | 25.2983                               |
| 23-056       | 23-056-WR1       | 10500                        | 21000                               | 0.000                 | 107.9042                           | 119.3794                           | 1.1938                         | 1.0790                                |
| 23-056       | 23-056-GW-1      | 0                            | 0                                   | 0.250                 | 8.9000                             | 10.1000                            | 0.0000                         | 0.0000                                |
| 23-058       | 23-058-WR1       | 975                          | 4400                                | 0.000                 | 6.7342                             | 7.4225                             | 0.2474                         | 0.2245                                |
| 23-058       | 23-058-SW-3      | 0                            | 0                                   | 0.000                 | 0.0000                             | 0.0000                             | 0.0000                         | 0.0000                                |
| 23-059       | 23-059-WR1       | 2900                         | 11250                               | 0.000                 | 16.6014                            | 18.4305                            | 1.8431                         | 1.6601                                |
| 23-059       | 23-059-WR2       | 1900                         | 17100                               | 0.000                 | 15.9289                            | 17.5403                            | 1.7540                         | 1.5929                                |
| 23-059       | 23-059-SW-2      | 0                            | 0                                   | 0.025                 | 7.3000                             | 8.2000                             | 0.0000                         | 0.0000                                |
| 23-079       | 23-079-TP-1      | 325                          | 1480                                | 0.000                 | 0.0377                             | 0.1230                             | 0.0041                         | 0.0013                                |
| 23-079       | 23-079-TP-2      | 325                          | 1480                                | 0.000                 | 0.0316                             | 0.1167                             | 0.0039                         | 0.0011                                |
| 25-005       | 25-005-WR-1      | 2100                         | 28800                               | 0.000                 | 4.1835                             | 4.4171                             | 0.4417                         | 0.4184                                |
| 25-005       | 25-005-WR-2      | 940                          | 4446                                | 0.000                 | 2.5607                             | 2.6604                             | 0.0887                         | 0.0854                                |
| 25-005       | 25-005-GW-1      | 0                            | 0                                   | 0.004                 | 0.2000                             | 0.2000                             | 0.0000                         | 0.0000                                |
| 25-007       | 25-007-WR-1      | 4900                         | 19450                               | 0.000                 | 30.6294                            | 31.2612                            | 1.0420                         | 1.0210                                |
| 25-007       | 25-007-WR-2      | 2000                         | 46665                               | 0.000                 | 6.0817                             | 6.3079                             | 0.6308                         | 0.6082                                |
| 25-007       | 25-007-GW-1      | 0                            | 0                                   | 0.064                 | 8.2000                             | 9.0000                             | 0.0000                         | 0.0000                                |
| 25-008       | 25-008-WR-1      | 5800                         | 5600                                | 0.000                 | 93.6241                            | 96.6720                            | 0.3222                         | 0.3121                                |
| 25-010       | 25-010-WR-1      | 8200                         | 21900                               | 0.000                 | 0.4266                             | 0.4971                             | 0.0166                         | 0.0142                                |
| 25-010       | 25-010-TP-1      | 730                          | 0                                   | 0.000                 | 0.1601                             | 0.2021                             | 0.0000                         | 0.0000                                |
| 25-019       | 25-019-WR-2      | 600                          | 3600                                | 0.000                 | 6.8297                             | 6.9538                             | 0.2318                         | 0.2277                                |
| 25-019       | 25-019-WR-1      | 3280                         | 17675                               | 0.000                 | 19.0584                            | 19.8518                            | 0.6617                         | 0.6353                                |
| 25-019       | 25-019-WR-3      | 2055                         | 13400                               | 0.000                 | 12.9244                            | 13.5287                            | 1.3529                         | 1.2924                                |
| 25-019       | 25-019-WR-4      | 6550                         | 25650                               | 0.000                 | 35.3214                            | 37.6402                            | 1.2547                         | 1.1774                                |
| 25-020       | 25-020-WR-2      | 1800                         | 9000                                | 0.000                 | 0.0532                             | 0.0577                             | 0.0006                         | 0.0005                                |
| 25-020       | 25-020-WR-1      | 19000                        | 18000                               | 0.000                 | 2.9001                             | 3.0296                             | 0.0303                         | 0.0290                                |
| 25-020       | 25-020-SW-5      | 0                            | 0                                   | 0.004                 | 0.1000                             | 0.1000                             | 0.0000                         | 0.0000                                |
| 25-030       | 25-030-TP-1      | 13500                        | 12500                               | 0.000                 | 56.6878                            | 59.0092                            | 0.5901                         | 0.5669                                |
| 25-040       | 25-040-WR-1      | 25                           | 1080                                | 0.000                 | 0.0006                             | 0.0006                             | 0.0006                         | 0.0006                                |
| 25-061       | 25-061-WR-1      | 23100                        | 72450                               | 0.000                 | 0.3967                             | 0.4132                             | 0.0041                         | 0.0040                                |
| 25-061       | 25-061-TP-1      | 39150                        | 221850                              | 0.000                 | 3.5523                             | 3.9254                             | 0.1308                         | 0.1184                                |
| 25-061       | 25-061-TP-2      | 25800                        | 0                                   | 0.000                 | 0.6478                             | 0.7158                             | 0.0000                         | 0.0000                                |
| 25-067       | 25-067-TP1-A     | 90909                        | 149760                              | 0.000                 | 22.4144                            | 23.0839                            | 0.7695                         | 0.7471                                |
| 25-067       | 25-067-TP1-B     | 109091                       | 0                                   | 0.000                 | 50.3086                            | 52.1557                            | 0.0000                         | 0.0000                                |
| 25-067       | 25-067-TP2-A     | 110000                       | 83160                               | 0.000                 | 76.8595                            | 80.1665                            | 0.0802                         | 0.0769                                |
| 25-067       | 25-067-TP2-B     | 66000                        | 0                                   | 0.000                 | 28.3908                            | 29.2170                            | 0.0000                         | 0.0000                                |
| 25-067       | 25-067-TP-3      | 2500                         | 13500                               | 0.000                 | 5.9184                             | 6.1998                             | 0.6200                         | 0.5918                                |
| 25-073       | 25-073-WR-1      | 10100                        | 12141                               | 0.000                 | 0.0044                             | 0.0082                             | 0.0001                         | 0.0000                                |
| 25-102       | 25-102-WR-1      | 6400                         | 29820                               | 0.000                 | 52.3708                            | 57.1533                            | 1.9051                         | 1.7457                                |
| 25-102       | 25-102-WR-2      | 8700                         | 38840                               | 0.000                 | 49.4263                            | 53.6441                            | 1.7881                         | 1.6475                                |
| 25-103       | 25-103-WR-1      | 2000                         | 7695                                | 0.000                 | 0.1041                             | 0.1185                             | 0.0012                         | 0.0010                                |
| 25-103       | 25-103-WR-2      | 1500                         | 5535                                | 0.000                 | 2.0942                             | 2.3043                             | 0.0230                         | 0.0209                                |
| 25-103       | 25-103-WR-3      | 1200                         | 7740                                | 0.000                 | 0.5243                             | 0.5970                             | 0.0060                         | 0.0052                                |
| 25-103       | 25-103-SW-2      | 0                            | 0                                   | 0.111                 | 2.0000                             | 2.1000                             | 0.0000                         | 0.0000                                |
| 25-115       | 25-115-TP-1      | 1500                         | 17200                               | 0.000                 | 11.4914                            | 12.6545                            | 1.2655                         | 1.1491                                |
| 25-116       | 25-116-WR-2      | 300                          | 2790                                | 0.000                 | 0.0005                             | 0.0005                             | 0.0000                         | 0.0000                                |
| 25-116       | 25-116-WR-1      | 1000                         | 9900                                | 0.000                 | 0.6197                             | 0.6914                             | 0.0069                         | 0.0062                                |
| 25-116       | 25-116-WR-4      | 1100                         | 16245                               | 0.000                 | 1.7245                             | 1.8977                             | 0.1898                         | 0.1724                                |
| 25-167       | 25-167-TP-1      | 40000                        | 40950                               | 0.000                 | 0.2516                             | 0.3117                             | 0.0010                         | 0.0008                                |
| 25-167       | 25-167-TP-2      | 17030                        | 11588                               | 0.000                 | 0.0232                             | 0.0276                             | 0.0003                         | 0.0002                                |
| 25-167       | 25-167-WR-1      | 18800                        | 37665                               | 0.000                 | 0.0157                             | 0.0217                             | 0.0002                         | 0.0002                                |
| 25-172       | 25-172-TP-1      | 420                          | 0                                   | 0.000                 | 0.0283                             | 0.0310                             | 0.0000                         | 0.0000                                |
| 25-172       | 25-172-TP-2      | 202000                       | 225990                              | 0.000                 | 127.4656                           | 140.3311                           | 1.4033                         | 1.2747                                |
| 25-172       | 25-172-TP-3      | 133400                       | 140940                              | 0.000                 | 194.8688                           | 214.4866                           | 2.1449                         | 1.9487                                |
| 25-175       | 25-175-TP-1      | 10000                        | 436600                              | 0.000                 | 138.8362                           | 153.6713                           | 15.3671                        | 13.8836                               |



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|--------------|------------------|------------------------------|-------------------------------------|-----------------------|------------------------------------|------------------------------------|--------------------------------|---------------------------------------|
| 25-175       | 25-175-TP-2      | 2500                         | 0                                   | 0.000                 | 7.2592                             | 8.0066                             | 0.0000                         | 0.0000                                |
| 25-175       | 25-175-TP-3      | 2500                         | 0                                   | 0.000                 | 10.6188                            | 11.7319                            | 0.0000                         | 0.0000                                |
| 25-179       | 25-179-WR-1      | 850                          | 2700                                | 0.000                 | 9.5887                             | 10.2430                            | 0.3414                         | 0.3196                                |
| 25-179       | 25-179-TP-1      | 16233                        | 54450                               | 0.000                 | 14.3615                            | 15.9294                            | 0.1593                         | 0.1436                                |
| 25-179       | 25-179-TP-2      | 26867                        | 0                                   | 0.000                 | 11.4282                            | 12.6610                            | 0.0000                         | 0.0000                                |
| 25-179       | 25-179-TP-3      | 0                            | 0                                   | 0.000                 | 0.0000                             | 0.0000                             | 0.0000                         | 0.0000                                |
| 25-179       | 25-179-TP-4      | 5600                         | 28314                               | 0.000                 | 7.6839                             | 8.4984                             | 0.2833                         | 0.2561                                |
| 25-197       | 25-197-TP-1      | 87500                        | 67950                               | 0.000                 | 1.1072                             | 1.2184                             | 0.0041                         | 0.0037                                |
| 25-197       | 25-197-TP-2      | 87500                        | 0                                   | 0.000                 | 6.2168                             | 6.8332                             | 0.0000                         | 0.0000                                |
| 25-208       | 25-208-TP-1      | 3700                         | 6000                                | 0.000                 | 7.6865                             | 8.4913                             | 0.0283                         | 0.0256                                |
| 25-208       | 25-208-WR-1      | 3860                         | 13900                               | 0.000                 | 2.4454                             | 2.7068                             | 0.0902                         | 0.0815                                |
| 25-208       | 25-208-WR-2      | 8500                         | 39700                               | 0.000                 | 4.7755                             | 5.3082                             | 0.1769                         | 0.1592                                |
| 25-208       | 25-208-WR-3      | 10000                        | 50000                               | 0.000                 | 3.3997                             | 3.7608                             | 0.0376                         | 0.0340                                |
| 25-208       | 25-208-SW-3      | 0                            | 0                                   | 0.047                 | 1.7000                             | 1.7000                             | 0.0000                         | 0.0000                                |
| 25-212       | 25-212-TP-1      | 2750                         | 21420                               | 0.000                 | 0.1901                             | 0.2163                             | 0.0216                         | 0.0190                                |
| 25-226       | 25-226-WR-1      | 14000                        | 34830                               | 0.000                 | 0.0013                             | 0.0015                             | 0.0000                         | 0.0000                                |
| 25-226       | 25-226-TP-1      | 1700                         | 2000                                | 0.000                 | 0.0000                             | 0.0000                             | 0.0000                         | 0.0000                                |
| 25-227       | 25-227-WR-1      | 25000                        | 45540                               | 0.000                 | 1.1671                             | 1.4281                             | 0.0143                         | 0.0117                                |
| 25-227       | 25-227-SW-3      | 0                            | 0                                   | 0.001                 | 0.0224                             | 0.0228                             | 0.0000                         | 0.0000                                |
| 25-280       | 25-280-WR-3      | 800                          | 2430                                | 0.000                 | 51.0869                            | 52.6095                            | 1.7536                         | 1.7029                                |
| 25-280       | 25-280-WR-2      | 800                          | 2430                                | 0.000                 | 3.9911                             | 4.2330                             | 0.1411                         | 0.1330                                |
| 25-314       | 25-365-TP-3      | 0                            | 0                                   | 0.000                 | 0.0000                             | 0.0000                             | 0.0000                         | 0.0000                                |
| 25-317       | 25-317-TP-1      | 1600                         | 22860                               | 0.000                 | 2.9320                             | 3.1995                             | 0.3199                         | 0.2932                                |
| 25-317       | 25-317-TP-2      | 400                          | 0                                   | 0.000                 | 1.2502                             | 1.3606                             | 0.0000                         | 0.0000                                |
| 25-322       | 25-322-TP1A-A    | 218                          | 3788                                | 0.000                 | 0.4434                             | 0.4910                             | 0.0491                         | 0.0443                                |
| 25-322       | 25-322-TP1A-B    | 218                          | 0                                   | 0.000                 | 0.0251                             | 0.0280                             | 0.0000                         | 0.0000                                |
| 25-322       | 25-322-TP1A-C    | 218                          | 0                                   | 0.000                 | 0.0322                             | 0.0373                             | 0.0000                         | 0.0000                                |
| 25-322       | 25-322-TP1A-D    | 218                          | 0                                   | 0.000                 | 0.0273                             | 0.0350                             | 0.0000                         | 0.0000                                |
| 25-322       | 25-322-TP1A-E    | 218                          | 0                                   | 0.000                 | 0.0051                             | 0.0060                             | 0.0000                         | 0.0000                                |
| 25-322       | 25-322-TP1B-A    | 218                          | 3788                                | 0.000                 | 0.8748                             | 0.9633                             | 0.0963                         | 0.0875                                |
| 25-322       | 25-322-TP1B-B    | 218                          | 0                                   | 0.000                 | 0.0173                             | 0.0203                             | 0.0000                         | 0.0000                                |
| 25-322       | 25-322-TP1B-C    | 218                          | 0                                   | 0.000                 | 0.0391                             | 0.0449                             | 0.0000                         | 0.0000                                |
| 25-322       | 25-322-TP1B-D    | 218                          | 0                                   | 0.000                 | 0.0190                             | 0.0223                             | 0.0000                         | 0.0000                                |
| 25-322       | 25-322-TP1B-E    | 217                          | 0                                   | 0.000                 | 0.0104                             | 0.0126                             | 0.0000                         | 0.0000                                |
| 25-322       | 25-322-TP1C-A    | 217                          | 3788                                | 0.000                 | 0.4282                             | 0.4867                             | 0.0487                         | 0.0428                                |
| 25-322       | 25-322-TP1C-B    | 217                          | 0                                   | 0.000                 | 0.0392                             | 0.0446                             | 0.0000                         | 0.0000                                |
| 25-322       | 25-322-TP1C-C    | 217                          | 0                                   | 0.000                 | 0.0371                             | 0.0490                             | 0.0000                         | 0.0000                                |
| 25-322       | 25-322-TP1C-D    | 217                          | 0                                   | 0.000                 | 0.0270                             | 0.0312                             | 0.0000                         | 0.0000                                |
| 25-322       | 25-322-TP1C-E    | 217                          | 0                                   | 0.000                 | 0.0048                             | 0.0059                             | 0.0000                         | 0.0000                                |
| 25-322       | 25-322-TP1D-A    | 217                          | 3787                                | 0.000                 | 0.5044                             | 0.5617                             | 0.0562                         | 0.0504                                |
| 25-322       | 25-322-TP1D-B    | 217                          | 0                                   | 0.000                 | 0.0070                             | 0.0079                             | 0.0000                         | 0.0000                                |
| 25-322       | 25-322-TP1D-C    | 217                          | 0                                   | 0.000                 | 0.0010                             | 0.0010                             | 0.0000                         | 0.0000                                |
| 25-322       | 25-322-TP1E-A    | 217                          | 3787                                | 0.000                 | 0.2806                             | 0.3089                             | 0.0309                         | 0.0281                                |
| 25-322       | 25-322-TP1E-B    | 217                          | 0                                   | 0.000                 | 0.0248                             | 0.0291                             | 0.0000                         | 0.0000                                |
| 25-322       | 25-322-TP1E-C    | 217                          | 0                                   | 0.000                 | 0.0105                             | 0.0249                             | 0.0000                         | 0.0000                                |
| 25-322       | 25-322-TP1E-D    | 217                          | 0                                   | 0.000                 | 0.0171                             | 0.0210                             | 0.0000                         | 0.0000                                |
| 25-322       | 25-322-TP1F-A    | 217                          | 3787                                | 0.000                 | 0.4405                             | 0.4868                             | 0.0487                         | 0.0441                                |
| 25-339       | 25-339-TP-1      | 300                          | 4950                                | 0.000                 | 0.3788                             | 0.4161                             | 0.0139                         | 0.0126                                |
| 25-339       | 25-339-WR-1      | 6050                         | 20970                               | 0.000                 | 19.0463                            | 20.9667                            | 0.6989                         | 0.6349                                |
| 25-339       | 25-339-WR-2      | 4300                         | 18000                               | 0.000                 | 0.9658                             | 1.0659                             | 0.0355                         | 0.0322                                |
| 25-339       | 25-339-LP-1      | 9700                         | 27790                               | 0.000                 | 1.4033                             | 1.5556                             | 0.0519                         | 0.0468                                |
| 25-365       | 25-365-TP-3      | 53750                        | 36333                               | 0.000                 | 1.5152                             | 1.8035                             | 0.0060                         | 0.0051                                |
| 25-365       | 25-365-TP-1      | 430000                       | 290667                              | 0.000                 | 94.8684                            | 126.1675                           | 0.4206                         | 0.3162                                |
| 25-365       | 25-365-TP-2      | 161250                       | 109000                              | 0.000                 | 24.7318                            | 31.3470                            | 0.3135                         | 0.2473                                |
| 25-365       | 25-365-TP-4      | 7000                         | 106200                              | 0.000                 | 0.8587                             | 0.9944                             | 0.3315                         | 0.2862                                |
| 25-365       | 25-365-TP-5      | 20800                        | 22500                               | 0.000                 | 8.6380                             | 11.4622                            | 0.1146                         | 0.0864                                |

# WASTE CHARACTERISTICS SCORE WORKSHEET

| PA<br>NUMBER | SAMPLE<br>NUMBER | WASTE<br>VOLUME<br>(CU. YD.) | UNCOV<br>WASTE<br>AREA<br>(SQ. FT.) | ADIT<br>FLOW<br>(CFS) | GRND W.<br>WASTE<br>CHAR.<br>SCORE | SURF W.<br>WASTE<br>CHAR.<br>SCORE | AIR<br>WASTE<br>CHAR.<br>SCORE | DIR. CONT.<br>WASTE<br>CHAR.<br>SCORE |
|--------------|------------------|------------------------------|-------------------------------------|-----------------------|------------------------------------|------------------------------------|--------------------------------|---------------------------------------|
| 39-003       | 39-003-WR-3      | 2865                         | 48785                               | 0.000                 | 7.1147                             | 7.5251                             | 0.7525                         | 0.7115                                |
| 39-003       | 39-003-GW-1      | 0                            | 0                                   | 0.033                 | 426.8000                           | 430.5000                           | 0.0000                         | 0.0000                                |
| 39-003       | 39-003-GW-2      | 0                            | 0                                   | 0.022                 | 2.3000                             | 2.4000                             | 0.0000                         | 0.0000                                |
| 39-003       | 39-003-GW-1AT    | 0                            | 0                                   | 0.000                 | 0.0000                             | 0.0000                             | 0.0000                         | 0.0000                                |
| 39-003       | 39-003-GW-1AD    | 0                            | 0                                   | 0.000                 | 0.0000                             | 0.0000                             | 0.0000                         | 0.0000                                |
| 39-004       | 39-004-WR-1      | 146525                       | 247200                              | 0.000                 | 2266.9834                          | 2366.3116                          | 23.6631                        | 22.6698                               |
| 39-004       | 39-004-WR-2      | 11600                        | 34092                               | 0.000                 | 120.5837                           | 126.8304                           | 1.2683                         | 1.2058                                |
| 39-004       | 39-004-WR-3      | 84000                        | 207600                              | 0.000                 | 169.4676                           | 175.7928                           | 5.8598                         | 5.6489                                |
| 39-004       | 39-004-TP-1      | 21400                        | 1350                                | 0.000                 | 79.9170                            | 81.5484                            | 0.0815                         | 0.0799                                |
| 39-006       | 39-006-WR-1      | 1500                         | 16200                               | 0.000                 | 22.8250                            | 23.8174                            | 2.3817                         | 2.2825                                |
| 39-006       | 39-006-WR-2      | 1100                         | 3600                                | 0.000                 | 31.3594                            | 32.4142                            | 0.3241                         | 0.3136                                |
| 39-006       | 39-006-GW-1      | 0                            | 0                                   | 0.033                 | 17.2000                            | 18.4000                            | 0.0000                         | 0.0000                                |
| 39-008       | 39-008-WR-1      | 4200                         | 8550                                | 0.000                 | 2.2931                             | 2.5269                             | 0.0084                         | 0.0076                                |
| 39-008       | 39-008-GW-1      | 0                            | 0                                   | 0.007                 | 0.2000                             | 0.2000                             | 0.0000                         | 0.0000                                |
| 39-010       | 39-010-TP-5      | 480                          | 3420                                | 0.000                 | 1.0500                             | 1.1114                             | 0.0370                         | 0.0350                                |
| 39-010       | 39-010-TP-1      | 595                          | 0                                   | 0.000                 | 0.9414                             | 0.9858                             | 0.0000                         | 0.0000                                |
| 39-010       | 39-010-TP-2      | 1425                         | 32796                               | 0.000                 | 4.0093                             | 4.1392                             | 0.4139                         | 0.4009                                |
| 39-010       | 39-010-GW-1      | 0                            | 0                                   | 0.056                 | 51.3000                            | 54.3000                            | 0.0000                         | 0.0000                                |
| 39-010       | 39-010-GW-2      | 0                            | 0                                   | 0.033                 | 0.6000                             | 0.7000                             | 0.0000                         | 0.0000                                |
| 39-012       | 39-012-WR-1      | 5000                         | 15400                               | 0.000                 | 0.7020                             | 0.7190                             | 0.0240                         | 0.0234                                |
| 39-012       | 39-012-GW-1      | 0                            | 0                                   | 0.064                 | 3.5000                             | 3.6000                             | 0.0000                         | 0.0000                                |
| 39-014       | 39-014-WR-1      | 300                          | 3960                                | 0.000                 | 1.1299                             | 1.1441                             | 0.0381                         | 0.0377                                |
| 39-014       | 39-014-WR-2      | 350                          | 7200                                | 0.000                 | 6.2854                             | 6.7801                             | 0.2260                         | 0.2095                                |
| 39-014       | 39-014-GW-1      | 0                            | 0                                   | 0.002                 | 0.1000                             | 0.1000                             | 0.0000                         | 0.0000                                |
| 39-018       | 39-018-WR-1      | 6500                         | 47295                               | 0.000                 | 9.4588                             | 9.7378                             | 0.3246                         | 0.3153                                |
| 39-020       | 39-020-WR-1      | 5500                         | 16200                               | 0.000                 | 19.6414                            | 20.7870                            | 0.6929                         | 0.6547                                |
| 39-020       | 39-020-WR-2      | 734                          | 3900                                | 0.000                 | 8.5162                             | 9.2674                             | 0.3089                         | 0.2839                                |
| 39-020       | 39-020-WR-3      | 1466                         | 7800                                | 0.000                 | 6.4086                             | 6.6076                             | 0.0661                         | 0.0641                                |
| 39-020       | 39-020-GW-1      | 0                            | 0                                   | 0.007                 | 6.4000                             | 6.6000                             | 0.0000                         | 0.0000                                |
| 39-022       | 39-022-WR-2      | 3000                         | 10800                               | 0.000                 | 34.1609                            | 37.6549                            | 1.2552                         | 1.1387                                |
| 39-022       | 39-022-WR-1      | 7720                         | 29970                               | 0.000                 | 7.1370                             | 7.7456                             | 0.2582                         | 0.2379                                |
| 39-023       | 39-023-WR-2      | 500                          | 2700                                | 0.000                 | 0.1317                             | 0.1348                             | 0.0045                         | 0.0044                                |
| 39-023       | 39-023-WR-1      | 760                          | 6700                                | 0.000                 | 0.1450                             | 0.1583                             | 0.0053                         | 0.0048                                |
| 39-024       | 39-024-WR-1      | 2700                         | 13050                               | 0.000                 | 0.2530                             | 0.2841                             | 0.0284                         | 0.0253                                |
| 39-044       | 39-044-WR-1      | 1150                         | 4500                                | 0.000                 | 5.4619                             | 5.6755                             | 0.0568                         | 0.0546                                |
| 39-044       | 39-044-WR-2      | 1080                         | 3825                                | 0.000                 | 16.2633                            | 16.9035                            | 0.1690                         | 0.1626                                |
| 39-044       | 39-044-SW-1      | 0                            | 0                                   | 0.010                 | 0.3000                             | 0.3000                             | 0.0000                         | 0.0000                                |
| 39-052       | 39-052-WRAVGX    | 90                           | 238                                 | 0.000                 | 0.0000                             | 0.0007                             | 0.0000                         | 0.0000                                |
| 39-062       | 39-062-WR-1      | 6500                         | 17190                               | 0.000                 | 3.7401                             | 3.9488                             | 0.1316                         | 0.1247                                |
| 39-062       | 39-062-GW-1      | 0                            | 0                                   | 0.011                 | 0.6000                             | 0.6000                             | 0.0000                         | 0.0000                                |
| 39-077       | 39-077-WR-1      | 1600                         | 26000                               | 0.000                 | 1.3243                             | 1.4033                             | 0.1403                         | 0.1324                                |
| 39-077       | 39-077-WR-2      | 400                          | 8700                                | 0.000                 | 0.1685                             | 0.1854                             | 0.0062                         | 0.0056                                |
| 41-003       | 41-003-WR-1      | 18110                        | 34200                               | 0.000                 | 11.8849                            | 12.5715                            | 0.1257                         | 0.1188                                |
| 41-003       | 41-003-WR-2      | 64000                        | 109800                              | 0.000                 | 1.7852                             | 2.4591                             | 0.0820                         | 0.0595                                |
| 41-003       | 41-003-TP-1      | 17000                        | 177700                              | 0.000                 | 77.0445                            | 82.4857                            | 8.2486                         | 7.7045                                |
| 41-003       | 41-003-TP-2      | 24000                        | 130800                              | 0.000                 | 48.5993                            | 52.6290                            | 5.2629                         | 4.8599                                |
| 41-004       | 41-004-WR-1      | 3000                         | 4950                                | 0.000                 | 0.7799                             | 0.8850                             | 0.0029                         | 0.0026                                |
| 41-004       | 41-004-GW-1      | 0                            | 0                                   | 0.002                 | 0.1000                             | 0.1000                             | 0.0000                         | 0.0000                                |
| 41-009       | 41-009-WR-1      | 2140                         | 23510                               | 0.000                 | 0.0501                             | 0.0572                             | 0.0057                         | 0.0050                                |
| 41-027       | 41-027-WR-1      | 362                          | 1710                                | 0.000                 | 0.0222                             | 0.0229                             | 0.0008                         | 0.0007                                |
| 45-002       | 45-002-WR-1      | 3800                         | 18540                               | 0.000                 | 13.9738                            | 15.3889                            | 0.5130                         | 0.4658                                |
| 45-002       | 45-002-GW-1      | 0                            | 0                                   | 0.007                 | 0.2000                             | 0.2000                             | 0.0000                         | 0.0000                                |
| 45-005       | 45-005-WR-1      | 200                          | 1584                                | 0.000                 | 5.7386                             | 6.3087                             | 0.6309                         | 0.5739                                |
| 45-005       | 45-005-WR-2      | 6000                         | 22275                               | 0.000                 | 57.7776                            | 63.4978                            | 2.1166                         | 1.9259                                |
| 45-005       | 45-005-GW-1      | 0                            | 0                                   | 0.056                 | 5.7000                             | 6.1000                             | 0.0000                         | 0.0000                                |
| 45-009       | 45-009-WR-1      | 10490                        | 29250                               | 0.000                 | 3.4057                             | 3.7458                             | 0.0375                         | 0.0341                                |



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|--------------|------------------|------------------------------|-------------------------------------|-----------------------|------------------------------------|------------------------------------|--------------------------------|---------------------------------------|
| 45-009       | 45-009-GW-1      | 0                            | 0                                   | 0.001                 | 0.0173                             | 0.0176                             | 0.0000                         | 0.0000                                |
| 45-009       | 45-009-GW-2      | 0                            | 0                                   | 0.004                 | 0.1000                             | 0.1000                             | 0.0000                         | 0.0000                                |
| 45-010       | 45-010-WR-2      | 650                          | 3240                                | 0.000                 | 8.2513                             | 9.0852                             | 0.3028                         | 0.2750                                |
| 45-010       | 45-010-WR-1      | 5650                         | 23240                               | 0.000                 | 12.8108                            | 14.1609                            | 0.4720                         | 0.4270                                |
| 45-010       | 45-010-GW-1      | 0                            | 0                                   | 0.005                 | 0.2000                             | 0.2000                             | 0.0000                         | 0.0000                                |
| 45-041       | 45-041-WR-1      | 250                          | 1000                                | 0.000                 | 0.0199                             | 0.0221                             | 0.0022                         | 0.0020                                |
| 45-041       | 45-041-GW-1      | 0                            | 0                                   | 0.002                 | 0.1000                             | 0.1000                             | 0.0000                         | 0.0000                                |
| 45-047       | 45-047-WR-1      | 290                          | 2736                                | 0.000                 | 0.2586                             | 0.2856                             | 0.0286                         | 0.0259                                |
| 47-027       | 47-027-WR-1      | 10025                        | 49860                               | 0.000                 | 10.9212                            | 11.2012                            | 0.1120                         | 0.1092                                |
| 47-028       | 47-028-WR-1      | 40000                        | 68850                               | 0.000                 | 2.9985                             | 6.5687                             | 0.0219                         | 0.0100                                |
| 47-028       | 47-028-GW-1      | 0                            | 0                                   | 0.033                 | 0.6000                             | 0.6000                             | 0.0000                         | 0.0000                                |
| 47-029       | 47-029-WR-1      | 4100                         | 3900                                | 0.000                 | 1.6227                             | 1.7746                             | 0.0059                         | 0.0054                                |
| 47-029       | 47-029-WR-2      | 2155                         | 19700                               | 0.000                 | 1.3408                             | 1.6409                             | 0.1641                         | 0.1341                                |
| 47-029       | 47-029-GW-1      | 0                            | 0                                   | 0.044                 | 0.7000                             | 1.0000                             | 0.0000                         | 0.0000                                |
| 47-035       | 47-035-WR-1      | 65000                        | 118800                              | 0.000                 | 24.2365                            | 26.3055                            | 0.8768                         | 0.8079                                |
| 47-035       | 47-035-WR-2      | 1620                         | 11475                               | 0.000                 | 1.8644                             | 2.0304                             | 0.2030                         | 0.1864                                |
| 47-035       | 47-035-SW-3      | 0                            | 0                                   | 0.056                 | 5.4000                             | 6.6000                             | 0.0000                         | 0.0000                                |
| 47-037       | 47-037-WR-1      | 2000                         | 17000                               | 0.000                 | 0.0007                             | 0.0012                             | 0.0001                         | 0.0001                                |
| 47-037       | 47-037-GW-1      | 0                            | 0                                   | 0.044                 | 0.6000                             | 0.6000                             | 0.0000                         | 0.0000                                |
| 47-081       | 47-081-TP-1      | 16000                        | 18000                               | 0.000                 | 2.6954                             | 3.3520                             | 0.0335                         | 0.0270                                |
| 47-081       | 47-081-TP-2      | 20500                        | 19350                               | 0.000                 | 4.0779                             | 5.2537                             | 0.0525                         | 0.0408                                |
| 48-001       | 48-001-WR-1      | 19666                        | 74996                               | 0.000                 | 3.9305                             | 4.0695                             | 0.0407                         | 0.0393                                |
| 48-001       | 48-001-WR-2      | 39334                        | 149991                              | 0.000                 | 6.6489                             | 6.8050                             | 0.2268                         | 0.2216                                |
| 48-001       | 48-001-WR-3      | 31400                        | 163080                              | 0.000                 | 0.0549                             | 0.0627                             | 0.0021                         | 0.0018                                |
| 48-001       | 48-001-SW-1      | 0                            | 0                                   | 0.078                 | 2.1000                             | 2.1000                             | 0.0000                         | 0.0000                                |
| 48-005       | 48-005-TP-3      | 0                            | 0                                   | 0.000                 | 0.0000                             | 0.0000                             | 0.0000                         | 0.0000                                |
| 48-005       | 48-005-TP-1      | 550                          | 2925                                | 0.000                 | 0.5519                             | 0.5618                             | 0.0187                         | 0.0184                                |
| 48-005       | 48-005-TP-2      | 5400                         | 5625                                | 0.000                 | 5.0303                             | 5.1258                             | 0.0171                         | 0.0168                                |
| 49-001       | 49-001-WR-1      | 195                          | 5620                                | 0.000                 | 0.0635                             | 0.0675                             | 0.0067                         | 0.0064                                |
| 49-002       | 49-002-TP-1      | 850                          | 13770                               | 0.000                 | 0.2359                             | 0.2568                             | 0.0856                         | 0.0786                                |
| 49-002       | 49-002-TP-2      | 850                          | 0                                   | 0.000                 | 0.0674                             | 0.0827                             | 0.0000                         | 0.0000                                |
| 49-002       | 49-002-WR-1      | 2700                         | 13320                               | 0.000                 | 2.5292                             | 2.8082                             | 0.2808                         | 0.2529                                |
| 49-002       | 49-002-WR-2      | 7450                         | 21510                               | 0.000                 | 1.1700                             | 1.3883                             | 0.0463                         | 0.0390                                |
| 49-002       | 49-002-GW-1      | 0                            | 0                                   | 0.033                 | 0.6000                             | 0.6000                             | 0.0000                         | 0.0000                                |

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| PA<br>NUMBER | SAMPLE<br>NUMBER | WASTE<br>VOLUME<br>(CU. YD.) | UNCOV<br>WASTE<br>AREA<br>(SQ. FT.) | ADIT<br>FLOW<br>(CFS) | GRND W.<br>WASTE<br>CHAR.<br>SCORE | SURF W.<br>WASTE<br>CHAR.<br>SCORE | AIR<br>WASTE<br>CHAR.<br>SCORE | DIR. CONT.<br>WASTE<br>CHAR.<br>SCORE |
|--------------|------------------|------------------------------|-------------------------------------|-----------------------|------------------------------------|------------------------------------|--------------------------------|---------------------------------------|
| 25-365       | 25-365-TP-6      | 0                            | 0                                   | 0.000                 | 0.0000                             | 0.0000                             | 0.0000                         | 0.0000                                |
| 27-005       | 27-005-TP-1      | 5000                         | 45000                               | 0.000                 | 144.4267                           | 157.9958                           | 5.2665                         | 4.8142                                |
| 27-005       | 27-005-WR-1      | 3990                         | 39060                               | 0.000                 | 187.4362                           | 205.3670                           | 6.8456                         | 6.2479                                |
| 27-006       | 27-006-TP-1      | 4540                         | 3500                                | 0.000                 | 32.5637                            | 35.7192                            | 0.1191                         | 0.1085                                |
| 27-055       | 27-055-WR-1      | 200                          | 680                                 | 0.000                 | 0.0003                             | 0.0004                             | 0.0000                         | 0.0000                                |
| 29-006       | 29-006-TP-1      | 1010                         | 4545                                | 0.000                 | 0.1175                             | 0.1426                             | 0.0014                         | 0.0012                                |
| 29-006       | 29-006-WR-1      | 2290                         | 6075                                | 0.000                 | 0.1813                             | 0.2054                             | 0.0021                         | 0.0018                                |
| 29-008       | 29-008-WR-1      | 16470                        | 14670                               | 0.000                 | 2.3690                             | 2.6802                             | 0.0268                         | 0.0237                                |
| 29-008       | 29-008-WR-2      | 12880                        | 42030                               | 0.000                 | 3.7617                             | 4.0011                             | 0.0400                         | 0.0376                                |
| 29-008       | 29-008-TP-1      | 12700                        | 95670                               | 0.000                 | 6.7993                             | 6.9683                             | 0.0697                         | 0.0680                                |
| 29-008       | 29-008-TP-2      | 35250                        | 0                                   | 0.000                 | 22.6615                            | 24.3182                            | 0.0000                         | 0.0000                                |
| 29-008       | 29-008-SW-3      | 0                            | 0                                   | 0.011                 | 0.2000                             | 0.2000                             | 0.0000                         | 0.0000                                |
| 29-010       | 29-010-WR-1      | 8500                         | 17865                               | 0.000                 | 1.6682                             | 1.8788                             | 0.0626                         | 0.0556                                |
| 29-010       | 29-010-TP-1      | 3000                         | 7000                                | 0.000                 | 1.5017                             | 1.6781                             | 0.0056                         | 0.0050                                |
| 29-010       | 29-010-SW-1      | 0                            | 0                                   | 0.001                 | 0.0120                             | 0.0122                             | 0.0000                         | 0.0000                                |
| 29-013       | 29-013-TP-1      | 24678                        | 52135                               | 0.000                 | 31.2713                            | 34.4233                            | 0.3442                         | 0.3127                                |
| 29-013       | 29-013-TP-2      | 31822                        | 62165                               | 0.000                 | 148.4111                           | 163.5843                           | 0.5453                         | 0.4947                                |
| 29-013       | 29-013-WR-1      | 138770                       | 115740                              | 0.000                 | 62.2227                            | 68.5281                            | 0.6853                         | 0.6222                                |
| 29-033       | 29-033-TP-1      | 35182                        | 174240                              | 0.000                 | 0.3801                             | 0.4144                             | 0.0138                         | 0.0127                                |
| 29-033       | 29-033-TP-2      | 29318                        | 0                                   | 0.000                 | 0.5408                             | 0.5956                             | 0.0000                         | 0.0000                                |
| 29-033       | 29-033-WR-1      | 1000                         | 2520                                | 0.000                 | 0.1401                             | 0.1544                             | 0.0015                         | 0.0014                                |
| 29-033       | 29-033-WR-2      | 18000                        | 39600                               | 0.000                 | 0.0294                             | 0.0396                             | 0.0004                         | 0.0003                                |
| 29-033       | 29-033-SS-1      | 0                            | 0                                   | 0.000                 | 0.0000                             | 0.0000                             | 0.0000                         | 0.0000                                |
| 29-033       | 29-033-SS-2      | 0                            | 0                                   | 0.000                 | 0.0000                             | 0.0000                             | 0.0000                         | 0.0000                                |
| 29-033       | 29-033-SW-3      | 0                            | 0                                   | 0.027                 | 0.8000                             | 1.3000                             | 0.0000                         | 0.0000                                |
| 29-034       | 29-034-TP-1      | 30545                        | 75600                               | 0.000                 | 2.4015                             | 2.7416                             | 0.0091                         | 0.0080                                |
| 29-034       | 29-034-TP-2      | 17455                        | 0                                   | 0.000                 | 3.2295                             | 3.6078                             | 0.0000                         | 0.0000                                |
| 29-034       | 29-034-TP-3      | 4400                         | 7560                                | 0.000                 | 0.4169                             | 0.4713                             | 0.0016                         | 0.0014                                |
| 29-034       | 29-034-TP-4      | 7200                         | 10440                               | 0.000                 | 0.9731                             | 1.1151                             | 0.0372                         | 0.0324                                |
| 29-034       | 29-034-TP-5      | 0                            | 0                                   | 0.000                 | 0.0000                             | 0.0000                             | 0.0000                         | 0.0000                                |
| 29-034       | 29-034-WR-1      | 16000                        | 50400                               | 0.000                 | 1.2861                             | 1.5098                             | 0.0151                         | 0.0129                                |
| 29-034       | 29-034-WR-2      | 9020                         | 57168                               | 0.000                 | 0.4117                             | 0.4915                             | 0.0164                         | 0.0137                                |
| 29-034       | 29-034-WR-3      | 1500                         | 17820                               | 0.000                 | 1.8736                             | 2.0685                             | 0.2069                         | 0.1874                                |
| 29-034       | 29-034-SW-3      | 0                            | 0                                   | 0.022                 | 0.6000                             | 0.6000                             | 0.0000                         | 0.0000                                |
| 29-038       | 29-038-WR-1      | 3020                         | 6310                                | 0.000                 | 4.5887                             | 5.0710                             | 0.0169                         | 0.0153                                |
| 29-038       | 29-038-WR-2      | 9800                         | 27235                               | 0.000                 | 0.8741                             | 1.0021                             | 0.0334                         | 0.0291                                |
| 29-038       | 29-038-TP-1      | 6463                         | 16515                               | 0.000                 | 1.1553                             | 1.2734                             | 0.0424                         | 0.0385                                |
| 29-038       | 29-038-TP-2      | 7012                         | 0                                   | 0.000                 | 1.7326                             | 1.9137                             | 0.0000                         | 0.0000                                |
| 29-038       | 29-038-SW-3      | 0                            | 0                                   | 0.020                 | 1.4000                             | 1.6000                             | 0.0000                         | 0.0000                                |
| 29-061       | 29-061-TP-1      | 8775                         | 47817                               | 0.000                 | 38.4809                            | 41.3154                            | 1.3772                         | 1.2827                                |
| 29-061       | 29-061-TP-2      | 2925                         | 0                                   | 0.000                 | 35.9915                            | 39.0883                            | 0.0000                         | 0.0000                                |
| 29-061       | 29-061-WR-3      | 1350                         | 8874                                | 0.000                 | 53.2681                            | 57.4681                            | 0.5747                         | 0.5327                                |
| 29-061       | 29-061-WR-1      | 310                          | 6651                                | 0.000                 | 2.7418                             | 2.9361                             | 0.0979                         | 0.0914                                |
| 29-061       | 29-061-WR-2      | 13525                        | 24417                               | 0.000                 | 371.0155                           | 399.1717                           | 3.9917                         | 3.7102                                |
| 29-073       | 29-073-WR-1      | 203                          | 1485                                | 0.000                 | 0.0283                             | 0.0321                             | 0.0032                         | 0.0028                                |
| 29-073       | 29-073-WR-2      | 890                          | 9090                                | 0.000                 | 0.6035                             | 0.6623                             | 0.0221                         | 0.0201                                |
| 29-073       | 29-073-TP-1A     | 24956                        | 89298                               | 0.000                 | 52.0846                            | 54.6764                            | 0.5468                         | 0.5208                                |
| 29-073       | 29-073-TP-1B     | 31194                        | 89298                               | 0.000                 | 381.6130                           | 400.8849                           | 1.3363                         | 1.2720                                |
| 29-078       | 29-078-WR-1      | 2579                         | 6164                                | 0.000                 | 1.2044                             | 1.3295                             | 0.0133                         | 0.0120                                |
| 29-078       | 29-078-WR-2      | 230                          | 4938                                | 0.000                 | 0.0553                             | 0.0611                             | 0.0061                         | 0.0055                                |
| 29-078       | 29-078-WR-3      | 3200                         | 9090                                | 0.000                 | 5.4372                             | 5.9973                             | 0.0200                         | 0.0181                                |
| 29-079       | 29-079-WR-1      | 25000                        | 67500                               | 0.000                 | 0.7764                             | 1.0130                             | 0.0101                         | 0.0078                                |
| 29-079       | 29-079-TP-1      | 2738                         | 15233                               | 0.000                 | 0.0507                             | 0.0769                             | 0.0077                         | 0.0051                                |
| 29-079       | 29-079-TP-2      | 1200                         | 0                                   | 0.000                 | 0.0728                             | 0.0990                             | 0.0000                         | 0.0000                                |
| 29-079       | 29-079-TP-3      | 512                          | 0                                   | 0.000                 | 0.0025                             | 0.0026                             | 0.0000                         | 0.0000                                |
| 29-079       | 29-079-SW-3      | 0                            | 0                                   | 0.002                 | 0.1000                             | 0.1000                             | 0.0000                         | 0.0000                                |



# WASTE CHARACTERISTICS SCORE WORKSHEET

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|--------------|------------------|------------------------------|-------------------------------------|-----------------------|------------------------------------|------------------------------------|--------------------------------|---------------------------------------|
| 29-082       | 29-082-WR-1      | 1000                         | 2700                                | 0.000                 | 0.2170                             | 0.2257                             | 0.0023                         | 0.0022                                |
| 29-082       | 29-082-TP-1      | 270000                       | 522720                              | 0.000                 | 26.2249                            | 28.9193                            | 0.2892                         | 0.2622                                |
| 29-082       | 29-082-TP-2      | 120000                       | 0                                   | 0.000                 | 63.1848                            | 67.1529                            | 0.0000                         | 0.0000                                |
| 29-082       | 29-082-TP-3      | 15500                        | 139500                              | 0.000                 | 5.7012                             | 5.9725                             | 0.5972                         | 0.5701                                |
| 29-082       | 29-082-GW-1      | 0                            | 0                                   | 0.870                 | 26.0000                            | 28.0000                            | 0.0000                         | 0.0000                                |
| 29-083       | 29-083-WR-1      | 14000                        | 31500                               | 0.000                 | 0.6031                             | 0.6773                             | 0.0068                         | 0.0060                                |
| 29-083       | 29-083-WR-2      | 28000                        | 42300                               | 0.000                 | 2.4083                             | 3.1995                             | 0.0320                         | 0.0241                                |
| 29-083       | 29-083-SW-3      | 0                            | 0                                   | 0.111                 | 1.8000                             | 1.8000                             | 0.0000                         | 0.0000                                |
| 29-102       | 29-102-WR-1      | 5000                         | 27000                               | 0.000                 | 0.5844                             | 0.7100                             | 0.0237                         | 0.0195                                |
| 29-102       | 29-102-WR-2      | 4080                         | 13838                               | 0.000                 | 1.8393                             | 1.9445                             | 0.0648                         | 0.0613                                |
| 29-103       | 29-103-WR-1      | 9900                         | 8100                                | 0.000                 | 0.3048                             | 0.3360                             | 0.0011                         | 0.0010                                |
| 29-103       | 29-103-TP-1      | 900                          | 0                                   | 0.000                 | 0.1699                             | 0.1866                             | 0.0000                         | 0.0000                                |
| 29-103       | 29-103-SW-2      | 0                            | 0                                   | 0.001                 | 0.0168                             | 0.0170                             | 0.0000                         | 0.0000                                |
| 29-105       | 29-105-WR-1      | 1500                         | 4950                                | 0.000                 | 0.0466                             | 0.0559                             | 0.0006                         | 0.0005                                |
| 29-105       | 29-105-WR-2      | 2425                         | 9547                                | 0.000                 | 0.2984                             | 0.3451                             | 0.0035                         | 0.0030                                |
| 29-105       | 29-105-WR-3      | 3035                         | 9450                                | 0.000                 | 0.9446                             | 1.1030                             | 0.0037                         | 0.0031                                |
| 29-106       | 29-106-WR-1      | 350                          | 2700                                | 0.000                 | 0.0229                             | 0.0274                             | 0.0009                         | 0.0008                                |
| 29-118       | 29-118-WR-1      | 5000                         | 10800                               | 0.000                 | 1.2300                             | 1.2816                             | 0.0427                         | 0.0410                                |
| 29-118       | 29-118-WR-2      | 185000                       | 405000                              | 0.000                 | 3.1420                             | 3.7216                             | 0.0372                         | 0.0314                                |
| 29-118       | 29-118-SW-3      | 0                            | 0                                   | 0.600                 | 17.4000                            | 17.9000                            | 0.0000                         | 0.0000                                |
| 29-121       | 29-121-WR-1      | 7100                         | 52200                               | 0.000                 | 0.3431                             | 0.3960                             | 0.0132                         | 0.0114                                |
| 29-121       | 29-121-TP-1      | 1500                         | 13500                               | 0.000                 | 2.8589                             | 3.1448                             | 0.3145                         | 0.2859                                |
| 29-121       | 29-121-SW-3      | 0                            | 0                                   | 0.030                 | 0.6000                             | 0.6000                             | 0.0000                         | 0.0000                                |
| 29-179       | 29-179-TP-1      | 68000                        | 127800                              | 0.000                 | 47.0230                            | 52.4391                            | 1.7480                         | 1.5674                                |
| 29-179       | 29-179-TP-2      | 29000                        | 78300                               | 0.000                 | 4.1648                             | 5.6677                             | 0.0567                         | 0.0416                                |
| 29-179       | 29-179-TP-3      | 10000                        | 67500                               | 0.000                 | 13.5008                            | 15.1337                            | 0.1513                         | 0.1350                                |
| 29-179       | 29-179-TP-4      | 0                            | 0                                   | 0.000                 | 0.0000                             | 0.0000                             | 0.0000                         | 0.0000                                |
| 29-179       | 29-179-TP-5      | 25000                        | 0                                   | 0.000                 | 39.3209                            | 43.4317                            | 0.0000                         | 0.0000                                |
| 29-179       | 29-179-WR-2      | 1500                         | 4950                                | 0.000                 | 0.0015                             | 0.0582                             | 0.0006                         | 0.0000                                |
| 29-179       | 29-179-WR-1      | 32500                        | 37890                               | 0.000                 | 120.7668                           | 133.0080                           | 0.4434                         | 0.4026                                |
| 29-282       | 29-282-WR-1      | 9350                         | 10467                               | 0.000                 | 1.9776                             | 2.1683                             | 0.0723                         | 0.0659                                |
| 29-282       | 29-282-WR-2      | 8880                         | 6120                                | 0.000                 | 3.4095                             | 3.7301                             | 0.0124                         | 0.0114                                |
| 29-285       | 29-285-WR-1      | 75                           | 720                                 | 0.000                 | 0.0069                             | 0.0075                             | 0.0003                         | 0.0002                                |
| 29-285       | 29-285-WR-2      | 330                          | 5740                                | 0.000                 | 1.6381                             | 1.8109                             | 0.0604                         | 0.0546                                |
| 29-293       | 29-293-WR-1      | 400                          | 2025                                | 0.000                 | 0.8761                             | 0.9697                             | 0.0323                         | 0.0292                                |
| 29-293       | 29-293-WR-2      | 1300                         | 5184                                | 0.000                 | 0.5594                             | 0.5970                             | 0.0060                         | 0.0056                                |
| 29-293       | 29-293-SW-1      | 0                            | 0                                   | 0.001                 | 0.0230                             | 0.0244                             | 0.0000                         | 0.0000                                |
| 29-354       | 29-354-WR-1      | 609                          | 3213                                | 0.000                 | 0.2003                             | 0.2294                             | 0.0076                         | 0.0067                                |
| 29-354       | 29-354-WR-2      | 13262                        | 24228                               | 0.000                 | 4.3930                             | 4.9466                             | 0.0495                         | 0.0439                                |
| 29-373       | 29-373-WR-1      | 4200                         | 16938                               | 0.000                 | 15.7761                            | 16.9218                            | 0.5641                         | 0.5259                                |
| 29-373       | 29-373-WR-2      | 1760                         | 4320                                | 0.000                 | 0.0300                             | 0.0399                             | 0.0004                         | 0.0003                                |
| 29-373       | 29-373-TP-1      | 6056                         | 0                                   | 0.000                 | 55.5050                            | 59.2972                            | 0.0000                         | 0.0000                                |
| 29-373       | 29-373-TP-2      | 6055                         | 0                                   | 0.000                 | 30.3304                            | 32.4193                            | 0.0000                         | 0.0000                                |
| 29-383       | 29-383-WR-1      | 18500                        | 82800                               | 0.000                 | 6.7859                             | 7.5616                             | 0.0756                         | 0.0679                                |
| 29-383       | 29-383-WR-2      | 100                          | 2700                                | 0.000                 | 0.0020                             | 0.0021                             | 0.0002                         | 0.0002                                |
| 29-383       | 29-383-SW-3      | 0                            | 0                                   | 0.104                 | 5.1000                             | 5.4000                             | 0.0000                         | 0.0000                                |
| 29-383       | 29-383-SW-5      | 0                            | 0                                   | 0.050                 | 8.7000                             | 9.0000                             | 0.0000                         | 0.0000                                |
| 29-394       | 29-394-WR-1      | 4600                         | 50400                               | 0.000                 | 8.3140                             | 8.9424                             | 0.2981                         | 0.2771                                |
| 29-394       | 29-394-SW-1      | 0                            | 0                                   | 0.001                 | 0.0268                             | 0.0271                             | 0.0000                         | 0.0000                                |
| 29-399       | 29-399-TP-1      | 4580                         | 12060                               | 0.000                 | 1.8350                             | 2.0096                             | 0.0670                         | 0.0612                                |
| 29-399       | 29-399-TP-2      | 600                          | 8730                                | 0.000                 | 0.5378                             | 0.5950                             | 0.0198                         | 0.0179                                |
| 29-399       | 29-399-TP-3      | 600                          | 0                                   | 0.000                 | 0.4559                             | 0.5033                             | 0.0000                         | 0.0000                                |
| 29-399       | 29-399-WR-1      | 1030                         | 4230                                | 0.000                 | 0.5337                             | 0.5870                             | 0.0059                         | 0.0053                                |
| 29-436       | 29-436-WR-2      | 6000                         | 15000                               | 0.000                 | 11.2058                            | 12.3802                            | 0.4127                         | 0.3735                                |
| 29-436       | 29-436-WR-3      | 2300                         | 4050                                | 0.000                 | 0.7363                             | 0.8106                             | 0.0081                         | 0.0074                                |
| 29-436       | 29-436-WR-1      | 30012                        | 75630                               | 0.000                 | 0.4781                             | 0.5358                             | 0.0018                         | 0.0016                                |

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|--------------|------------------|------------------------------|-------------------------------------|-----------------------|------------------------------------|------------------------------------|--------------------------------|---------------------------------------|
| 29-436       | 29-436-TP-1      | 13300                        | 72000                               | 0.000                 | 13.8549                            | 15.2901                            | 0.1529                         | 0.1385                                |
| 29-436       | 29-436-SW-3      | 0                            | 0                                   | 0.016                 | 0.6000                             | 0.6000                             | 0.0000                         | 0.0000                                |
| 29-436       | 29-436-SW-4      | 0                            | 0                                   | 0.016                 | 0.5000                             | 0.6000                             | 0.0000                         | 0.0000                                |
| 29-449       | 29-449-WR-1      | 2835                         | 26460                               | 0.000                 | 0.2337                             | 0.2615                             | 0.0262                         | 0.0234                                |
| 29-449       | 29-449-SW-1      | 0                            | 0                                   | 0.045                 | 0.5000                             | 0.6000                             | 0.0000                         | 0.0000                                |
| 29-451       | 29-451-WR-1      | 150                          | 0                                   | 0.000                 | 0.0889                             | 0.0981                             | 0.0000                         | 0.0000                                |
| 29-451       | 29-451-WR-2      | 4200                         | 24300                               | 0.000                 | 31.2190                            | 34.4507                            | 1.1484                         | 1.0406                                |
| 29-451       | 29-451-TP-1      | 3150                         | 12870                               | 0.000                 | 2.2196                             | 2.4519                             | 0.0817                         | 0.0740                                |
| 29-451       | 29-451-TP-2      | 3950                         | 0                                   | 0.000                 | 2.2196                             | 2.4634                             | 0.0000                         | 0.0000                                |
| 29-455       | 29-455-WR-1      | 2500                         | 9000                                | 0.000                 | 0.0010                             | 0.0074                             | 0.0001                         | 0.0000                                |
| 29-455       | 29-455-WR-2      | 1350                         | 4050                                | 0.000                 | 0.0472                             | 0.0563                             | 0.0006                         | 0.0005                                |
| 29-455       | 29-455-WR-3      | 2050                         | 0                                   | 0.000                 | 0.5114                             | 0.5321                             | 0.0000                         | 0.0000                                |
| 29-473       | 29-473-WR-1      | 1530                         | 23400                               | 0.000                 | 0.3243                             | 0.3573                             | 0.0357                         | 0.0324                                |
| 29-474       | 29-474-WR-1      | 7309                         | 51345                               | 0.000                 | 45.4687                            | 49.7977                            | 1.6599                         | 1.5156                                |
| 29-474       | 29-474-WR-2      | 1290                         | 15930                               | 0.000                 | 2.1480                             | 2.1864                             | 0.2186                         | 0.2148                                |
| 29-474       | 29-474-WR-3      | 2430                         | 20785                               | 0.000                 | 6.8337                             | 7.3102                             | 0.7310                         | 0.6834                                |
| 29-474       | 29-474-WR-4      | 3190                         | 15750                               | 0.000                 | 30.7888                            | 32.6404                            | 1.0880                         | 1.0263                                |
| 29-476       | 29-476-WR-1      | 1170                         | 7415                                | 0.000                 | 0.6307                             | 0.6913                             | 0.0069                         | 0.0063                                |
| 29-476       | 29-476-WR-2      | 630                          | 4752                                | 0.000                 | 1.4761                             | 1.5967                             | 0.0532                         | 0.0492                                |
| 29-476       | 29-476-WR-3      | 4100                         | 15624                               | 0.000                 | 8.5278                             | 9.3863                             | 0.3129                         | 0.2843                                |
| 30-004       | 30-004-SL-1      | 0                            | 0                                   | 0.000                 | 0.0000                             | 0.0000                             | 0.0000                         | 0.0000                                |
| 30-004       | 30-004-WR-1      | 10000                        | 28857                               | 0.000                 | 529.6938                           | 582.1639                           | 5.8216                         | 5.2969                                |
| 30-004       | 30-004-WR-2      | 10680                        | 58298                               | 0.000                 | 156.8200                           | 171.9981                           | 1.7200                         | 1.5682                                |
| 30-007       | 30-007-WR-1      | 900                          | 5913                                | 0.000                 | 0.1054                             | 0.1202                             | 0.0040                         | 0.0035                                |
| 30-007       | 30-007-WR-2      | 4600                         | 36828                               | 0.000                 | 0.0007                             | 0.0607                             | 0.0020                         | 0.0000                                |
| 30-007       | 30-007-SW-4      | 0                            | 0                                   | 0.004                 | 0.1000                             | 0.1000                             | 0.0000                         | 0.0000                                |
| 30-017       | 30-017-WR-1      | 275                          | 3870                                | 0.000                 | 0.4159                             | 0.4563                             | 0.0456                         | 0.0416                                |
| 30-019       | 30-019-WR-1      | 735                          | 3790                                | 0.000                 | 0.3323                             | 0.3659                             | 0.0122                         | 0.0111                                |
| 30-067       | 30-067-WR-1      | 7470                         | 42390                               | 0.000                 | 0.0483                             | 0.0938                             | 0.0031                         | 0.0016                                |
| 30-067       | 30-067-TP-1      | 25                           | 360                                 | 0.000                 | 0.0004                             | 0.0011                             | 0.0001                         | 0.0000                                |
| 30-067       | 30-067-GW-1      | 0                            | 0                                   | 0.033                 | 0.6000                             | 0.6000                             | 0.0000                         | 0.0000                                |
| 30-067       | 30-067-GW-2      | 0                            | 0                                   | 0.100                 | 1.7000                             | 1.7000                             | 0.0000                         | 0.0000                                |
| 30-069       | 30-069-WR-1      | 2000                         | 12240                               | 0.000                 | 0.0002                             | 0.0114                             | 0.0011                         | 0.0000                                |
| 30-069       | 30-069-WR-2      | 10450                        | 49680                               | 0.000                 | 0.0707                             | 0.0778                             | 0.0008                         | 0.0007                                |
| 30-078       | 30-078-WR-1      | 18                           | 180                                 | 0.000                 | 0.0369                             | 0.0406                             | 0.0041                         | 0.0037                                |
| 30-078       | 30-078-WR-2      | 10000                        | 23000                               | 0.000                 | 7.4886                             | 8.2905                             | 0.0829                         | 0.0749                                |
| 31-001       | 31-001-WR-1      | 13000                        | 32400                               | 0.000                 | 8.1103                             | 8.6929                             | 0.0869                         | 0.0811                                |
| 31-001       | 31-001-WR-2      | 2875                         | 20025                               | 0.000                 | 0.3972                             | 0.4407                             | 0.0441                         | 0.0397                                |
| 31-001       | 31-001-WR-3      | 15000                        | 87000                               | 0.000                 | 4.3626                             | 4.9225                             | 0.0492                         | 0.0436                                |
| 31-001       | 31-001-SW-1      | 0                            | 0                                   | 0.004                 | 0.9000                             | 0.9000                             | 0.0000                         | 0.0000                                |
| 31-003       | 31-003-WR-1      | 800                          | 2000                                | 0.000                 | 4.3345                             | 4.6868                             | 0.1562                         | 0.1445                                |
| 31-003       | 31-003-WR-2      | 4500                         | 8350                                | 0.000                 | 1.1289                             | 1.1905                             | 0.0040                         | 0.0038                                |
| 31-003       | 31-003-GW-1      | 0                            | 0                                   | 0.011                 | 0.2000                             | 0.2000                             | 0.0000                         | 0.0000                                |
| 31-010       | 31-010-WR-1      | 6500                         | 24840                               | 0.000                 | 0.6966                             | 0.7813                             | 0.0260                         | 0.0232                                |
| 31-010       | 31-010-TP-1      | 140                          | 1350                                | 0.000                 | 1.9193                             | 2.0664                             | 0.2066                         | 0.1919                                |
| 31-010       | 31-010-TP-2      | 228                          | 4932                                | 0.000                 | 1.7232                             | 1.8560                             | 0.1856                         | 0.1723                                |
| 31-010       | 31-010-GW-1      | 0                            | 0                                   | 0.022                 | 3.8000                             | 3.8000                             | 0.0000                         | 0.0000                                |
| 31-021       | 31-021-WR-1      | 1275                         | 4140                                | 0.000                 | 0.0077                             | 0.0086                             | 0.0001                         | 0.0001                                |
| 31-021       | 31-021-GW-1      | 0                            | 0                                   | 0.110                 | 1.7000                             | 1.8000                             | 0.0000                         | 0.0000                                |
| 31-049       | 31-049-WR-1      | 1150                         | 32145                               | 0.000                 | 0.0854                             | 0.0988                             | 0.0099                         | 0.0085                                |
| 31-049       | 31-049-TP-1      | 80                           | 1425                                | 0.000                 | 0.0032                             | 0.0036                             | 0.0012                         | 0.0011                                |
| 31-067       | 31-067-WR-1      | 400                          | 2180                                | 0.000                 | 0.0009                             | 0.0019                             | 0.0001                         | 0.0000                                |
| 31-072       | 31-072-WR-1      | 400                          | 3600                                | 0.000                 | 13.5553                            | 14.7874                            | 0.4929                         | 0.4518                                |
| 31-072       | 31-072-WR-2      | 7370                         | 38880                               | 0.000                 | 35.5330                            | 38.9907                            | 1.2997                         | 1.1844                                |
| 31-073       | 31-073-WR-1      | 3000                         | 17280                               | 0.000                 | 16.9037                            | 18.1793                            | 0.6060                         | 0.5635                                |
| 31-074       | 31-074-WR-1      | 9500                         | 21150                               | 0.000                 | 0.1001                             | 0.1253                             | 0.0042                         | 0.0033                                |



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|--------------|------------------|------------------------------|-------------------------------------|-----------------------|------------------------------------|------------------------------------|--------------------------------|---------------------------------------|
| 31-074       | 31-074-GW-1      | 0                            | 0                                   | 0.001                 | 0.0170                             | 0.0175                             | 0.0000                         | 0.0000                                |
| 31-077       | 31-077-WR-1      | 9200                         | 31500                               | 0.000                 | 8.3037                             | 9.2547                             | 0.3085                         | 0.2768                                |
| 31-077       | 31-077-GW-1      | 0                            | 0                                   | 0.001                 | 0.0207                             | 0.0211                             | 0.0000                         | 0.0000                                |
| 31-078       | 31-078-WR-1      | 400                          | 0                                   | 0.000                 | 0.1447                             | 0.1620                             | 0.0000                         | 0.0000                                |
| 31-082       | 31-082-TP-1      | 16333                        | 308700                              | 0.000                 | 122.7516                           | 134.4681                           | 13.4468                        | 12.2752                               |
| 31-090       | 31-090-TP-1      | 145775                       | 351500                              | 0.000                 | 264.7342                           | 293.7229                           | 2.9372                         | 2.6473                                |
| 31-090       | 31-090-TP-2      | 59075                        | 0                                   | 0.000                 | 164.5677                           | 175.1879                           | 0.0000                         | 0.0000                                |
| 32-005       | 32-005-WR-1      | 320000                       | 315000                              | 0.000                 | 219.9936                           | 241.5126                           | 0.8050                         | 0.7333                                |
| 32-005       | 32-005-WR-2      | 1200                         | 9720                                | 0.000                 | 0.8264                             | 0.9098                             | 0.0091                         | 0.0083                                |
| 32-010       | 32-010-WR-1      | 68300                        | 139140                              | 0.000                 | 2.5254                             | 3.0331                             | 0.1011                         | 0.0842                                |
| 32-011       | 32-011-WR-1      | 3700                         | 22320                               | 0.000                 | 10.2425                            | 11.3019                            | 0.3767                         | 0.3414                                |
| 32-017       | 32-017-WR-1      | 5220                         | 19350                               | 0.000                 | 14.6154                            | 16.0911                            | 0.5364                         | 0.4872                                |
| 32-017       | 32-017-TP-1      | 11500                        | 17550                               | 0.000                 | 13.8340                            | 14.1950                            | 0.1419                         | 0.1383                                |
| 32-017       | 32-017-WR-4      | 11500                        | 0                                   | 0.000                 | 141.8660                           | 155.9213                           | 0.0000                         | 0.0000                                |
| 32-033       | 32-033-WR-1      | 63600                        | 324000                              | 0.000                 | 0.4496                             | 0.4914                             | 0.0164                         | 0.0150                                |
| 32-033       | 32-033-WR-2      | 2100                         | 18900                               | 0.000                 | 0.1190                             | 0.1305                             | 0.0130                         | 0.0119                                |
| 32-042       | 32-042-WR-1      | 1300                         | 8800                                | 0.000                 | 2.4381                             | 2.6801                             | 0.0268                         | 0.0244                                |
| 32-042       | 32-042-GW-1      | 0                            | 0                                   | 0.003                 | 0.1000                             | 0.1000                             | 0.0000                         | 0.0000                                |
| 32-048       | 32-048-WR-1      | 1700                         | 2600                                | 0.000                 | 0.0923                             | 0.1061                             | 0.0011                         | 0.0009                                |
| 32-049       | 32-049-WR-1      | 290                          | 2190                                | 0.000                 | 0.0029                             | 0.0061                             | 0.0006                         | 0.0003                                |
| 32-057       | 32-057-WR-1      | 3800                         | 10330                               | 0.000                 | 0.0300                             | 0.0454                             | 0.0015                         | 0.0010                                |
| 34-004       | 34-004-WR-1      | 8000                         | 8100                                | 0.000                 | 0.2501                             | 0.5350                             | 0.0018                         | 0.0008                                |
| 34-004       | 34-004-TP-1      | 111000                       | 25000                               | 0.000                 | 1.5917                             | 11.6494                            | 0.0116                         | 0.0016                                |
| 34-004       | 34-004-TP-2      | 259000                       | 0                                   | 0.000                 | 3.1261                             | 20.7769                            | 0.0000                         | 0.0000                                |
| 34-006       | 34-006-WR-2      | 7                            | 100                                 | 0.000                 | 0.0004                             | 0.0010                             | 0.0003                         | 0.0001                                |
| 34-006       | 34-006-WR-1      | 17000                        | 54000                               | 0.000                 | 1.2466                             | 1.8134                             | 0.0181                         | 0.0125                                |
| 34-006       | 34-006-TP-1      | 782                          | 15000                               | 0.000                 | 0.0299                             | 0.0704                             | 0.0235                         | 0.0100                                |
| 34-006       | 34-006-GW-1      | 0                            | 0                                   | 0.150                 | 5.7000                             | 10.8000                            | 0.0000                         | 0.0000                                |
| 34-006       | 34-006-GW-2      | 0                            | 0                                   | 0.002                 | 0.1000                             | 0.1000                             | 0.0000                         | 0.0000                                |
| 34-007       | 34-007-WR-1      | 4000                         | 9000                                | 0.000                 | 0.2195                             | 0.3299                             | 0.0011                         | 0.0007                                |
| 34-007       | 34-007-WR-2      | 4000                         | 9000                                | 0.000                 | 0.1510                             | 0.1999                             | 0.0007                         | 0.0005                                |
| 34-007       | 34-007-GW-1      | 0                            | 0                                   | 0.095                 | 1.8000                             | 1.8000                             | 0.0000                         | 0.0000                                |
| 34-009       | 34-009-WR-1      | 800                          | 15300                               | 0.000                 | 0.0261                             | 0.0505                             | 0.0168                         | 0.0087                                |
| 34-009       | 34-009-WR-2      | 820                          | 4590                                | 0.000                 | 0.0837                             | 0.1107                             | 0.0037                         | 0.0028                                |
| 34-009       | 34-009-WR-3      | 1600                         | 6228                                | 0.000                 | 0.0016                             | 0.0089                             | 0.0001                         | 0.0000                                |
| 34-009       | 34-009-GW-1      | 0                            | 0                                   | 0.009                 | 1.8000                             | 2.0000                             | 0.0000                         | 0.0000                                |
| 34-010       | 34-010-WR-3      | 87500                        | 76230                               | 0.000                 | 2.4300                             | 4.9450                             | 0.0165                         | 0.0081                                |
| 34-010       | 34-010-WR-1      | 1500                         | 5850                                | 0.000                 | 0.0250                             | 0.1638                             | 0.0016                         | 0.0002                                |
| 34-010       | 34-010-WR-2      | 262500                       | 228690                              | 0.000                 | 2.3246                             | 12.8732                            | 0.1287                         | 0.0232                                |
| 34-018       | 34-018-WR-1      | 5300                         | 42900                               | 0.000                 | 0.0003                             | 0.0080                             | 0.0003                         | 0.0000                                |
| 34-018       | 34-018-WR-2      | 330                          | 1035                                | 0.000                 | 0.0003                             | 0.0065                             | 0.0002                         | 0.0000                                |
| 34-018       | 34-018-GW-1      | 0                            | 0                                   | 0.223                 | 7.3000                             | 9.0000                             | 0.0000                         | 0.0000                                |
| 34-079       | 34-079-WR-1      | 1100                         | 2835                                | 0.000                 | 14.5120                            | 16.0112                            | 0.1601                         | 0.1451                                |
| 34-079       | 34-079-SW-3      | 0                            | 0                                   | 0.004                 | 0.1000                             | 0.2000                             | 0.0000                         | 0.0000                                |
| 34-085       | 34-085-WR-1      | 6200                         | 42120                               | 0.000                 | 0.2967                             | 0.5064                             | 0.0169                         | 0.0099                                |
| 34-085       | 34-085-WR-2      | 400                          | 2790                                | 0.000                 | 0.9934                             | 1.0990                             | 0.0366                         | 0.0331                                |
| 34-090       | 34-090-WR-2      | 1800                         | 877                                 | 0.000                 | 0.1285                             | 0.1458                             | 0.0001                         | 0.0001                                |
| 34-090       | 34-090-WR-1      | 3100                         | 7830                                | 0.000                 | 2.8953                             | 3.2729                             | 0.0109                         | 0.0097                                |
| 34-090       | 34-090-GW-1      | 0                            | 0                                   | 0.000                 | 0.0000                             | 0.0000                             | 0.0000                         | 0.0000                                |
| 34-090       | 34-090-GW-2      | 0                            | 0                                   | 0.000                 | 0.0000                             | 0.0000                             | 0.0000                         | 0.0000                                |
| 34-090       | 34-090-SW-3      | 0                            | 0                                   | 0.002                 | 0.1000                             | 0.1000                             | 0.0000                         | 0.0000                                |
| 34-093       | 34-093-WR-1      | 2400                         | 5040                                | 0.000                 | 0.0609                             | 0.1213                             | 0.0012                         | 0.0006                                |
| 39-003       | 39-003-TP-1      | 3000                         | 32760                               | 0.000                 | 54.3049                            | 55.4859                            | 1.8495                         | 1.8102                                |
| 39-003       | 39-003-TP-2      | 3000                         | 0                                   | 0.000                 | 247.8278                           | 253.7426                           | 0.0000                         | 0.0000                                |
| 39-003       | 39-003-WR-1      | 14000                        | 162450                              | 0.000                 | 44.8166                            | 46.7786                            | 4.6779                         | 4.4817                                |
| 39-003       | 39-003-WR-2      | 2000                         | 46300                               | 0.000                 | 25.7135                            | 26.9561                            | 2.6956                         | 2.5713                                |

**DATA VALIDATION AND EVALUATION REPORT**  
**FOR THE**  
**ABANDONED MINES**  
**HAZARDOUS MATERIALS INVENTORY**

**Abandoned Mine Reclamation Bureau  
Montana Department of State Lands  
1625 11th Avenue  
Helena, Montana 59620**

**MARCH 1994**





**MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINES AND RECLAMATION BUREAU**

**ABANDONED HARDROCK MINE PRIORITY SITES  
DATA VALIDATION AND EVALUATION REPORT**

**PREPARED FOR:**

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## 1.0 INTRODUCTION

This document is a summary of the validation and evaluation of analytical data compiled during the Montana Department of State Lands/Abandoned Mines Reclamation Bureau (MDSL/AMRB), Abandoned Mines Hazardous Materials Inventory. The Hazardous Materials Inventory was conducted during late spring through early fall of 1993. The data discussed in this report represent the analytical results of source (tailings, waste rock, slag, etc.), soil, sediment, surface water, and groundwater samples. The data include the analytical results reported by the laboratory as well as data provided by the field portable X-Ray Fluorescence (XRF) Spectrometer. Pioneer Technical Services, Inc. (Pioneer) has prepared this Data Validation and Evaluation Report for MDSL/AMRB under the provisions of the Engineering Services Agreement DSL-AMRB No. 004.

The objectives of the Data Validation and Evaluation Report include:

- summarize the laboratory data validation process according to U.S. Environmental Protection Agency (EPA) guidelines;
- summarize the XRF data validation process, performed according to guidelines provided by the instrument manufacturer;
- evaluate the laboratory data using a precision, accuracy, representativeness, completeness, and comparability (PARCC) statement according to U.S. EPA guidelines; and,
- evaluate the overall precision and representativeness of the field XRF data using standard statistical comparison techniques, and compare field-generated XRF data to analytical laboratory generated data.

## 2.0 DATA VALIDATION

Data validation is the process of determining the limitations of analytical data after the data have been reported by the laboratory or the XRF spectrometer. The analytical laboratory utilized for this investigation (MSE, Inc.) is a participant in the EPA's Contract Laboratory Program (CLP). Analytical laboratories which have met rigorous testing requirements are allowed to participate in the CLP Program; labs participating in the CLP must comply with the CLP Statement of Work (SOW) which outlines reporting and deliverable requirements, analytical methods, quality assurance/quality control (QA/QC) procedures, etc. The MSE Laboratory complied with all of the QA/QC performance requirements defined in the CLP SOW when analyzing the samples for this investigation. The data packages did not include all of the QA/QC documentation specified by the CLP SOW; the requested deliverable packages were modified to avoid unnecessary costs yet still provide sufficient QA/QC information to allow comprehensive data validation and evaluation procedures. Data evaluation occurred at the project office where a reviewer

assessed the data by using the data validation guidelines developed by the EPA. The validation process applied limitations to data if certain conditions outlined in the EPA guidance documents were not met.

The limitations applied to the data were identified by data qualifiers (See Table 2-1). Knowing the limitations of the data assists the data user when making interpretations. Data with limitations (flagged data) are usable for interpretive purposes provided that the qualifications are considered. For example, a "J" flag indicates that the reported concentration was estimated (the laboratory did not meet the specified control limits for accuracy or precision, or a contaminant was detected in a preparation blank, etc.). "J" flagged data meets the identification criteria (the analyte was definitely detected), but not the quantitation criteria (the concentration cannot be exactly quantified). After the validation process was complete, data were assigned into data use categories including: unrestricted; restricted; and, unusable.

The laboratory data validated and evaluated for this investigation included a list of 13 metals from the CLP Target Analyte List (TAL). A total of 60 soil sample batches and 46 water sample batches were analyzed at the laboratory over the duration of the investigation; and over 3,200 samples were analyzed in the field using the field portable XRF spectrometer.

The QA/QC performance requirements specified for laboratory data by the CLP were administered on a per batch basis with a restricted number of samples analyzed per batch. For example, a preparation blank, laboratory duplicate, and matrix spike, etc., were analyzed with each batch, and the results of these QA/QC analyses were representative of the entire batch.

When a sample was analyzed using the XRF spectrometer, the analysis would take several minutes to complete; the exact length of time was controlled by the operator. Throughout the duration of the analysis, the XRF would analyze the sample several times and store several concentrations for each analyte in memory. When the analysis was complete, the concentration reported by the XRF represented the mean of the concentrations stored in memory for each analyte for a particular sample. The standard deviation was also reported with the mean concentration for each analyte.

The XRF data were validated by a data reviewer; the validation procedure consisted of comparing the reported concentration with the associated standard deviation. Per the instrument manufacturer's guidelines, any concentration that was less than three times (3X) the corresponding standard deviation was considered to be below the instrument detection limit (or not distinguishable from background) and was not reported. Those XRF data reported where the concentration was greater than 3X but less than 10X the standard deviation were flagged with a "\*\*\*", indicating an estimated concentration.

**TABLE 2-1**

**INORGANIC DATA QUALIFIERS**

**DATA QUALIFIERS**

- <sup>1</sup>U - The material was analyzed for, but was not detected at the level of the associated value. The associated value was either the sample quantitation limit (SQL) or the instrument detection limit (IDL).
- <sup>1</sup>J - The associated value was an estimated concentration; the laboratory did not meet all required QA/QC objectives.
- <sup>1</sup>R - The data were rejected as unusable; the flagged analyte may or may not be present.
- <sup>1</sup>UJ- The analyte was analyzed for, but was not detected. The associated value was an estimate and may be inaccurate or imprecise.
- X - Data outlier based on statistical analysis of the entire data set. Data qualified with an "X" were not considered when determining overall precision and accuracy statements.

<sup>1</sup> From Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses (USEPA 1988).



If the sample standard deviation information was not available for review (lost during the data transfer process, or hand recorded data was available for review without the associated standard deviation values), the XRF data were flagged with a "\$", indicating that the data could not be validated.

The laboratory data were validated according to the document Laboratory Data Validation Functional Guidelines for Evaluating Inorganics (EPA 1988). The data validation procedures were performed partially by the laboratory chemists, and partially by a Pioneer data reviewer. The overall data validation procedure included an evaluation of the following items:

- holding times;
- initial and continuing calibrations;
- calibration and preparation blanks;
- inductively coupled plasma (ICP) interference check samples;
- laboratory control samples (LCS);
- laboratory duplicate sample analyses;
- matrix spike sample analyses;
- furnace atomic absorption (AA) quality control (QC);
- ICP serial dilutions;
- sample result verification;
- field duplicate samples; and,
- overall assessment of data for the batch.

The following is a brief summary of the validation results for the soil (solid matrix) and water data reported for this investigation. The most intensive data validation procedures were performed on the data reported by the laboratory (in accordance with EPA Guidelines); the XRF data were validated according to instrument manufacturer specifications.

Holding time requirements were met for all water samples submitted to the laboratory. Holding time requirements have not been established for soil samples; however, if the water holding time criteria were applied to soil samples, no holding time exceedences occurred. Additionally, all initial and continuing calibration requirements were met for soil and water samples for the entire data set.

No contaminants were detected above the Contract Required Detection Limit (CRDL) in water sample preparation blanks for the entire data set. However, several analytes (As, Hg, Pb, and Zn) were detected above the CRDL in soil sample preparation blanks for nine (9) separate soil sample batches. This resulted in flagging 11.7% of the arsenic data, 1.7% of the mercury data, 1.7% of the lead data, and 1.7% of the zinc data as estimated concentrations ("J" flag).

The requirements for running and meeting the control limits for ICP interference check samples were met for all soil and water samples, and Laboratory Control Sample (LCS) results were in control for all soil and water analyses.

Laboratory duplicate analyses yielded the following results. For water analyses, the percentage of data qualified for each analyte where laboratory duplicate results were not within the CLP-specified control limits ( $\pm 20\%$ ) for concentrations  $>5x$  the CRDL are listed in Table 2-2 (the affected data were flagged "J"). Similarly, laboratory duplicate results for soil analyses that were not within the CLP-specified control limits ( $\pm 35\%$ ) for concentrations  $>5x$  the CRDL are also listed in Table 2-2 (the affected data were flagged "J").

**TABLE 2-2**  
**DATA QUALIFIED DUE TO LABORATORY DUPLICATE RESULTS**  
**OUTSIDE CLP-SPECIFIED CONTROL LIMITS**

| <u>Analyte</u> | <u>Qualified<br/>Water Data</u> | <u>Qualified<br/>Soil Data</u> |
|----------------|---------------------------------|--------------------------------|
| Arsenic        | 15.2%                           | 28.3%                          |
| Barium         | 4.3%                            | 18.3%                          |
| Cadmium        | 23.9%                           | 23.3%                          |
| Cobalt         | 2.1%                            | 20.0%                          |
| Chromium       | 21.7%                           | 18.3%                          |
| Copper         | 39.1%                           | 16.7%                          |
| Iron           | 19.6%                           | 10.0%                          |
| Mercury        | 34.8%                           | 28.3%                          |
| Manganese      | 10.9%                           | 21.7%                          |
| Nickel         | 10.9%                           | 30.0%                          |
| Lead           | 28.3%                           | 15.0%                          |
| Zinc           | 23.9%                           | 20.0%                          |
| Antimony       |                                 | 11.7%                          |

Matrix spike results (water and soil) that were not within the CLP-specified accuracy range (75% - 125% for both matrices) caused the entire batch to be qualified with a "J" flag (for the specific analyte exceeding the control limit). Table 2-3 lists the percentage of data qualified for each analyte and media based on matrix spike results:

TABLE 2-3

**DATA QUALIFIED DUE TO MATRIX SPIKE RESULTS  
OUTSIDE CLP-SPECIFIED ACCURACY RANGE**

| <u>Analyte</u> | <u>Qualified<br/>Water Data</u> | <u>Qualified<br/>Soil Data</u> |
|----------------|---------------------------------|--------------------------------|
| Arsenic        | 10.9%                           | 13.3%                          |
| Barium         |                                 | 25.0%                          |
| Cadmium        |                                 | 15.0%                          |
| Cobalt         |                                 | 6.7%                           |
| Chromium       |                                 | 11.7%                          |
| Copper         |                                 | 18.3%                          |
| Iron           | 4.3%                            |                                |
| Mercury        |                                 | 33.3%                          |
| Manganese      |                                 | 21.7%                          |
| Nickel         |                                 | 11.7%                          |
| Lead           | 10.9%                           | 15.0%                          |
| Antimony       |                                 | 61.7%                          |
| Zinc           |                                 | 18.3%                          |

The furnace AA QC requirements for duplicate injections and post digestion spikes and the ICP serial dilution requirements were met for all soil and water samples for the entire data set. Sample result verification determined that all soil and water quantitation results were accurate. An overall assessment of the data indicates that all data were usable with some limitations. More limitations were associated with the soil data due to usual matrix affects. The matrix affects were demonstrated by recurrent control limit exceedences with duplicate analyses and matrix spike analyses. The water data have relatively few limitations; the most frequent problem encountered with the water analyses was laboratory duplicate results outside CLP-specified control limits.

All XRF data were validated according to manufacturer specifications (currently no EPA guidelines exist for validating/evaluating XRF data) and all XRF data that fell outside the manufacturer's guidelines were appropriately flagged or not reported; the overall representativeness of the XRF data is discussed in Section 3.3 of this report.

### 3.0 DATA EVALUATION

Data evaluation was performed after the data validation process was completed and most of the limitations were applied to the data. The data evaluation process involved a statistical analysis of the data to identify outliers. The purpose of the data evaluation process was to prepare an overall PARCC statement as outlined in the document Statement of Work for Inorganics Analysis (EPA 1988). The PARCC statement presents how much of the data meets the DQOs outlined in the Final QAPjP for the Abandoned



Mines Hazardous Materials Inventory. The DQOs are qualitative and quantitative statements that specify the data quality required to support CERCLA-related activities.

### 3.1 PRECISION

Precision is a measure of the amount of scatter or variance that occurs among several measurements of a particular analyte. The relative standard deviation (RSD) of the laboratory duplicate analyses was used to generate the overall precision statement for each analyte.

In addition to using the laboratory duplicate results to calculate an overall precision statement, overall precision was calculated for each analyte for the following types of analogous samples:

- 1) Field Duplicate - Field duplicate samples were collected for the groundwater matrix only during the investigation. Groundwater was expected to be the most homogeneous environmental media and was expected to provide the most comparable results. Field duplicates were samples that were split in the field and submitted to the laboratory without being identified as such (blind). Field duplicate results are discussed in Section 3.3.1 of this report.
- 2) XRF Field Duplicate - XRF field duplicates were applicable to the solid matrix only. XRF field duplicates were samples that were analyzed twice in the field to determine the reproducibility of the XRF Spectrometer results. XRF field duplicate results are discussed in Section 3.3.1 of this report.
- 3) Independent Analyses - Several split samples (solid matrix only) were analyzed by separate laboratories to determine the reproducibility of the reported laboratory results. Independent analyses are discussed in Section 3.3.2 of this report.
- 4) XRF/Laboratory Splits - XRF/Laboratory splits were also applicable to the solid matrix only. XRF/Laboratory splits were analyzed in the field using the XRF Spectrometer and a split of the sample was submitted to the laboratory for analysis. These split samples were expected to provide highly variable results due to the heterogeneous nature of the solid matrix and due to the very different analytical methods and detection limits (XRF spectrometry vs. acid extraction/atomic absorption). XRF/Laboratory split results are discussed in Section 3.3.3 of this report.

The statistical methods used to calculate the overall precision statement for the laboratory data were discussed in the Final QAPjP for the Abandoned Mines Hazardous Materials Inventory and are included as Appendix A to this report. Data acceptance or rejection was based on the application of the Dixon Q-Test, a statistical method that evaluates the relative standard deviation (RSD) calculated for laboratory duplicate analyses. A single duplicate analysis was conducted for each batch of soil and water samples analyzed at



the laboratory for each analyte. Tables 3-1 and 3-2 present the overall precision statements for each analyte for the water and soil matrices, respectively; only laboratory duplicates were used in calculating the percent precision reported in Tables 3-1 and 3-2. Tables 3-1 and 3-2 also include the confidence interval with which the calculations were based and the overall completeness of the data. Completeness is a measure of the ratio of the number of duplicate pairs not evaluated as data outliers compared to the overall number of duplicate pairs (number of sample batches not evaluated as outliers / total number of sample batches analyzed by the laboratory). Percent precision can be interpreted as follows: the concentration data for each analyte lie within the indicated percent precision (+/-) of the reported value.

Laboratory duplicates were generated at the laboratory by splitting a field sample prior to digestion or extraction, and analyzing the two splits as separate samples. The concentrations of the duplicate analyses were compared and the relative percent difference (RPD) between them was calculated and reported. For the evaluation of RPDs and RSDs, if a duplicate pair provided concentration results which were both less than the instrument detection limit (reported as "<IDL" by the laboratory), the RPD and RSD were evaluated as 0.0%. If only one of the duplicate results was "<IDL" and the other was a detected concentration, then the detected concentration and the IDL concentration were used to calculate the RPD and RSD. Table 3-3 presents the RPDs calculated for each analyte for the water matrix, for each sample batch, as reported by the laboratory. Table 3-4 presents the RPDs calculated for each analyte for the soil matrix, for each sample batch, as reported by the laboratory.

### 3.2 ACCURACY

Accuracy is defined as the ability of the analytical procedure to determine the known quantity of a particular substance in a sample. The standard deviation (SD) of the laboratory matrix spike (MS) was used to generate the overall accuracy statement for the water and soil matrices. The statistical methods used to calculate accuracy were outlined in the Final Quality Assurance Project Plan for the Abandoned Mines Hazardous Materials Inventory and are included in Appendix A of this report. Data acceptance or rejection was based upon the percent recovery (%R) of the MS. However, according to EPA guidelines, those recoveries where the concentration of the analyte in the unspiked sample exceeds the spiking concentration by greater than four times (4X) were not used for the accuracy evaluation.

Tables 3-5 and 3-6 present accuracy statements for the water and soil matrices, respectively. Accuracy was reported as a percent range of uncertainty; only the laboratory matrix spike was used in evaluating the overall accuracy reported in the tables. The tables also include the confidence interval with which calculations were based and the overall completeness of the data (completeness is the measure of the number of MS recoveries not evaluated as outliers compared to the total number of MS recoveries reported). The accuracy statements are interpreted as follows: the data lie within the percent range of uncertainty, plus or minus the percent precision of the indicated value.

TABLE 3-1: PRECISION STATEMENT FOR WATER DATA USING THE LABORATORY DUPLICATE

| ANALYTE   | CONFIDENCE INTERVAL | COMPLETENESS/NUMBER OF OUTLIERS | PERCENT PRECISION |
|-----------|---------------------|---------------------------------|-------------------|
| Arsenic   | 90%                 | 100% / None                     | +/- 3.35          |
| Barium    | 90%                 | 96% / Two                       | +/- 0.62          |
| Cadmium   | 90%                 | 100% / None                     | +/- 2.90          |
| Cobalt    | 90%                 | 98% / One                       | +/- 0.34          |
| Chromium  | 90%                 | 100% / None                     | +/- 3.07          |
| Copper    | 90%                 | 100% / None                     | +/- 5.60          |
| Iron      | 90%                 | 98% / One                       | +/- 2.58          |
| Mercury   | 90%                 | 100% / None                     | +/- 4.58          |
| Manganese | 90%                 | 96% / Two                       | +/- 1.26          |
| Nickle    | 90%                 | 98% / One                       | +/- 1.39          |
| Lead      | 90%                 | 98% / One                       | +/- 2.81          |
| Antimony  | 90%                 | 100% / None                     | +/- 0.15          |
| Zinc      | 90%                 | 98% / One                       | +/- 3.57          |

A 10% risk of false rejection was used to assess outliers

TABLE 3-2: PRECISION STATEMENT FOR SOIL DATA USING THE LABORATORY DUPLICATE

| ANALYTE   | CONFIDENCE INTERVAL | COMPLETENESS/NUMBER OF OUTLIERS | PERCENT PRECISION |
|-----------|---------------------|---------------------------------|-------------------|
| Arsenic   | 90%                 | 100% / None                     | +/- 3.89          |
| Barium    | 90%                 | 100% / None                     | +/- 2.88          |
| Cadmium   | 90%                 | 98% / One                       | +/- 3.43          |
| Cobalt    | 90%                 | 96% / Two                       | +/- 2.74          |
| Chromium  | 90%                 | 100% / None                     | +/- 3.17          |
| Copper    | 90%                 | 100% / None                     | +/- 3.24          |
| Iron      | 90%                 | 98% / One                       | +/- 2.21          |
| Mercury   | 90%                 | 96% / Two                       | +/- 4.12          |
| Manganese | 90%                 | 100% / None                     | +/- 3.40          |
| Nickle    | 90%                 | 98% / One                       | +/- 3.57          |
| Lead      | 90%                 | 100% / None                     | +/- 3.23          |
| Antimony  | 90%                 | 100% / None                     | +/- 2.32          |
| Zinc      | 90%                 | 100% / None                     | +/- 3.13          |

A 10% risk of false rejection was used to assess outliers

**TABLE 3-3: WATER DATA PRECISION REQUIREMENTS (RELATIVE PERCENT DIFFERENCE OF LABORATORY DUPLICATE) AND RESULTS**

|                        |       | As    | Ba     | Cd   | Co     | Cr   | Cu    | Fe     | Hg    | Mn      | Ni      | Pb      | Sb   | Zn      |
|------------------------|-------|-------|--------|------|--------|------|-------|--------|-------|---------|---------|---------|------|---------|
| Required Precision (%) |       | 20.0  | 20.0   | 20.0 | 20.0   | 20.0 | 20.0  | 20.0   | 20.0  | 20.0    | 20.0    | 20.0    | 20.0 | 20.0    |
| Achieved Precision (%) |       |       |        |      |        |      |       |        |       |         |         |         |      |         |
| Batch                  | C1001 | 0.0   | 0.3    | 23.9 | 0.0    | 0.0  | 46.6  | 2.6    | 0.0   | 0.0     | 0.0     | 0.0     | 0.0  | 0.0     |
| Batch                  | C1009 | 0.9   | 0.7    | 0.0  | 0.0    | 0.0  | 0.0   | 4.2    | 60.4  | 0.0     | 0.0     | 0.0     | 0.0  | 0.0     |
| Batch                  | C1015 | 0.0   | 0.0    | 0.0  | 0.0    | 0.0  | 0.0   | 0.0    | 0.0   | 0.0     | 0.0     | 10.6    | 0.0  | 5.5     |
| Batch                  | C1023 | 49.1  | 4.5    | 8.0  | 1.4    | 0.0  | 2.5   | 2.2    | 0.0   | 2.2     | 2.4     | 30.9    | 0.0  | 8.0     |
| Batch                  | C703  | 17.2  | 0.8    | 0.0  | 0.0    | 84.8 | 74.9  | 0.6    | 62.4  | 0.0     | 0.0     | 0.0     | 0.0  | 0.0     |
| Batch                  | C705  | 0.0   | 4.6    | 0.0  | 0.0    | 49.2 | 13.1  | 8.5    | 29.4  | 33.1    | 0.0     | 20.9    | 0.0  | 34.3    |
| Batch                  | C730  | 5.1   | 2.9    | 53.9 | 0.0    | 0.0  | 1.1   | 26.3   | 7.9   | 110.3 * | 0.0     | 49.8    | 0.0  | 2.5     |
| Batch                  | C732  | 13.3  | 19.4   | 0.0  | 0.0    | 56.5 | 44.0  | 10.2   | 0.0   | 4.5     | 1.7     | 16.4    | 0.0  | 4.0     |
| Batch                  | C735  | 6.8   | 1.5    | 2.4  | 2.9    | 0.0  | 0.9   | 0.8    | 59.0  | 0.8     | 10.1    | 0.4     | 0.0  | 1.6     |
| Batch                  | C737  | 3.4   | 0.2    | 12.8 | 0.0    | 0.0  | 0.7   | 1.6    | 0.0   | 0.9     | 0.0     | 5.3     | 7.7  | 0.6     |
| Batch                  | C740  | 1.5   | 0.8    | 12.3 | 0.0    | 9.5  | 0.1   | 2.2    | 4.7   | 2.0     | 5.3     | 5.2     | 0.0  | 2.4     |
| Batch                  | C742  | 0.7   | 0.8    | 0.0  | 0.0    | 0.0  | 7.2   | 4.4    | 30.5  | 1.6     | 0.0     | 23.2    | 0.0  | 5.0     |
| Batch                  | C771  | 0.0   | 1.7    | 0.0  | 0.0    | 0.0  | 87.1  | 14.3   | 4.5   | 19.7    | 36.2    | 0.0     | 0.0  | 0.0     |
| Batch                  | C781  | 0.0   | 4.9    | 0.0  | 0.0    | 0.0  | 0.7   | 7.2    | 0.0   | 5.3     | 0.0     | 0.0     | 0.0  | 10.8    |
| Batch                  | C788  | 2.2   | 1.2    | 35.6 | 45.9 * | 0.0  | 6.6   | 2.3    | 0.0   | 3.2     | 17.2    | 0.0     | 0.0  | 5.1     |
| Batch                  | C813  | 34.5  | 6.6    | 47.7 | 0.0    | 0.0  | 21.6  | 0.0    | 0.0   | 10.7    | 0.0     | 0.8     | 0.0  | 5.8     |
| Batch                  | C817  | 3.4   | 85.7 * | 0.0  | 0.0    | 34.4 | 21.5  | 7.0    | 32.9  | 10.5    | 0.0     | 12.4    | 0.0  | 57.3    |
| Batch                  | C818  | 0.7   | 9.3    | 0.0  | 0.0    | 57.7 | 84.6  | 58.0   | 0.0   | 71.8 *  | 0.0     | 107.3 * | 0.0  | 72.3    |
| Batch                  | C819  | 22.8  | 7.0    | 0.0  | 0.0    | 0.0  | 52.3  | 0.0    | 104.3 | 0.0     | 0.0     | 24.0    | 0.0  | 0.0     |
| Batch                  | C851  | 30.1  | 2.8    | 53.9 | 0.0    | 0.0  | 3.9   | 8.0    | 14.8  | 1.1     | 0.0     | 3.4     | 0.0  | 32.1    |
| Batch                  | C853  | 1.0   | 2.3    | 0.0  | 0.0    | 0.0  | 3.1   | 0.0    | 10.0  | 25.0    | 0.0     | 57.4    | 0.0  | 69.6    |
| Batch                  | C862  | 5.4   | 0.0    | 45.9 | 0.0    | 0.0  | 0.0   | 1.4    | 0.0   | 1.4     | 0.0     | 45.6    | 1.4  | 5.0     |
| Batch                  | C864  | 0.3   | 0.9    | 75.2 | 0.0    | 0.0  | 3.2   | 13.4   | 0.0   | 0.0     | 0.0     | 0.0     | 0.0  | 0.0     |
| Batch                  | C866  | 0.0   | 2.5    | 0.0  | 0.0    | 0.0  | 0.0   | 6.8    | 0.0   | 0.0     | 0.0     | 0.0     | 0.0  | 0.0     |
| Batch                  | C868  | 3.7   | 20.8 * | 22.9 | 0.0    | 42.1 | 99.5  | 55.3   | 0.0   | 0.0     | 2.2     | 59.5    | 0.0  | 31.5    |
| Batch                  | C885  | 0.0   | 3.8    | 0.0  | 0.0    | 0.0  | 0.0   | 9.3    | 7.7   | 30.4    | 0.0     | 3.3     | 0.0  | 0.0     |
| Batch                  | C889  | 10.1  | 6.2    | 0.0  | 0.0    | 0.0  | 34.7  | 59.0   | 11.4  | 15.3    | 4.3     | 0.0     | 0.0  | 143.6 * |
| Batch                  | C896  | 10.3  | 0.7    | 0.0  | 0.0    | 0.0  | 0.0   | 20.6   | 16.8  | 0.0     | 0.0     | 48.5    | 0.0  | 0.0     |
| Batch                  | C899  | 9.9   | 1.7    | 4.3  | 2.8    | 0.0  | 1.8   | 1.5    | 35.7  | 1.1     | 1.2     | 3.2     | 0.0  | 1.2     |
| Batch                  | C904  | 0.0   | 2.2    | 0.0  | 0.0    | 0.0  | 0.0   | 4.2    | 108.6 | 2.9     | 3.0     | 19.2    | 0.0  | 0.0     |
| Batch                  | C909  | 83.2  | 6.5    | 0.0  | 0.0    | 0.0  | 0.0   | 39.5   | 59.9  | 0.0     | 0.0     | 4.9     | 0.0  | 29.9    |
| Batch                  | C912  | 10.2  | 5.3    | 0.0  | 17.2   | 0.0  | 3.2   | 4.8    | 29.9  | 5.0     | 35.8    | 1.7     | 0.0  | 4.9     |
| Batch                  | C914  | 17.9  | 2.0    | 29.7 | 2.7    | 17.4 | 0.7   | 0.4    | 2.6   | 0.2     | 21.9    | 12.4    | 0.0  | 0.5     |
| Batch                  | C916  | 0.0   | 4.0    | 0.0  | 0.0    | 0.0  | 3.7   | 1.9    | 5.4   | 4.4     | 0.0     | 27.7    | 0.0  | 9.1     |
| Batch                  | C918  | 16.9  | 5.8    | 0.0  | 0.0    | 33.4 | 4.8   | 6.6    | 75.1  | 6.1     | 0.0     | 0.9     | 0.0  | 5.2     |
| Batch                  | C920  | 10.8  | 4.8    | 0.0  | 0.0    | 0.0  | 20.3  | 17.1   | 0.0   | 5.9     | 0.0     | 0.0     | 0.0  | 0.0     |
| Batch                  | C935  | 2.8   | 5.2    | 0.0  | 0.0    | 0.0  | 26.1  | 12.5   | 26.4  | 2.3     | 41.5    | 51.0    | 0.0  | 35.6    |
| Batch                  | C937  | 72.0  | 0.6    | 0.0  | 0.0    | 24.4 | 35.6  | 21.3   | 0.0   | 18.7    | 0.0     | 0.0     | 0.0  | 15.4    |
| Batch                  | C939  | 3.0   | 1.4    | 0.0  | 0.0    | 0.0  | 35.0  | 5.4    | 0.0   | 0.0     | 0.0     | 0.0     | 0.0  | 3.3     |
| Batch                  | C943  | 16.4  | 1.9    | 45.9 | 0.0    | 0.0  | 31.4  | 4.6    | 34.1  | 0.2     | 0.0     | 5.0     | 0.0  | 7.1     |
| Batch                  | C959  | 4.9   | 8.7    | 0.0  | 0.0    | 40.8 | 6.2   | 11.8   | 86.4  | 5.0     | 5.0     | 12.9    | 0.0  | 73.6    |
| Batch                  | C968  | 2.0   | 4.3    | 0.0  | 0.0    | 0.0  | 128.1 | 57.3   | 1.6   | 0.0     | 0.0     | 0.0     | 0.0  | 0.0     |
| Batch                  | C987  | 110.9 | 3.2    | 0.0  | 0.0    | 63.6 | 166.0 | 94.2 * | 0.0   | 0.0     | 0.0     | 21.3    | 0.0  | 0.0     |
| Batch                  | C991  | 0.0   | 0.2    | 0.0  | 0.0    | 0.0  | 0.0   | 15.3   | 0.0   | 0.0     | 0.0     | 2.5     | 0.0  | 16.5    |
| Batch                  | C997  | 11.4  | 1.5    | 50.2 | 0.0    | 2.5  | 116.6 | 6.3    | 40.8  | 10.2    | 113.3 * | 1.2     | 0.0  | 97.2    |
| Batch                  | C999  | 1.1   | 2.8    | 1.9  | 1.3    | 8.1  | 4.0   | 5.3    | 8.1   | 2.1     | 0.6     | 0.9     | 0.0  | 14.6    |

\* = Outlier based on statistical analysis of data.



**TABLE 3-4: SOIL DATA PRECISION REQUIREMENTS (RELATIVE PERCENT DIFFERENCE OF LABORATORY DUPLICATE) AND RESULTS**

|                        |  | As                     | Ba   | Cd      | Co      | Cr   | Cu   | Fe     | Hg      | Mn   | Ni      | Pb    | Sb   | Zn   |
|------------------------|--|------------------------|------|---------|---------|------|------|--------|---------|------|---------|-------|------|------|
| Required Precision (%) |  | 35.0                   | 35.0 | 35.0    | 35.0    | 35.0 | 35.0 | 35.0   | 35.0    | 35.0 | 35.0    | 35.0  | 35.0 | 35.0 |
| Batch                  |  | Relative Precision (%) |      |         |         |      |      |        |         |      |         |       |      |      |
| Batch C1003            |  | 50.9                   | 40.0 | 0.0     | 4.7     | 15.4 | 2.0  | 39.5   | 1.2     | 12.0 | 44.4    | 80.9  | 0.0  | 55.1 |
| Batch C1004            |  | 69.8                   | 4.8  | 0.0     | 23.8    | 64.2 | 10.1 | 22.6   | 78.8    | 34.7 | 38.3    | 5.3   | 0.0  | 14.3 |
| Batch C1005            |  | 42.2                   | 43.9 | 0.0     | 17.7    | 24.7 | 41.7 | 32.4   | 16.4    | 14.3 | 40.1    | 47.3  | 0.0  | 24.4 |
| Batch C1006            |  | 74.7                   | 15.5 | 29.4    | 2.1     | 12.4 | 31.8 | 24.9   | 0.0     | 8.2  | 18.9    | 30.9  | 0.0  | 34.3 |
| Batch C1007            |  | 0.0                    | 43.9 | 0.0     | 49.0    | 4.0  | 87.5 | 27.6   | 25.3    | 21.4 | 0.0     | 21.8  | 0.0  | 29.4 |
| Batch C1008            |  | 31.9                   | 17.8 | 0.0     | 12.8    | 20.4 | 4.1  | 12.7   | 8.4     | 11.9 | 15.6    | 31.4  | 0.0  | 5.7  |
| Batch C1022            |  | 16.6                   | 16.7 | 0.0     | 21.2    | 16.5 | 11.2 | 17.1   | 65.5    | 17.5 | 15.4    | 4.5   | 0.0  | 18.3 |
| Batch C1028            |  | 96.4                   | 7.2  | 41.8    | 10.4    | 72.8 | 24.1 | 78.1 * | 18.3    | 14.6 | 28.8    | 5.5   | 0.0  | 36.4 |
| Batch C1029            |  | 7.9                    | 3.4  | 0.0     | 2.8     | 5.0  | 2.5  | 1.1    | 6.1     | 2.4  | 3.4     | 1.4   | 0.0  | 1.2  |
| Batch C1080            |  | 14.4                   | 45.4 | 74.5    | 26.3    | 35.8 | 15.7 | 3.0    | 71.1    | 69.9 | 32.4    | 44.6  | 13.5 | 55.0 |
| Batch C1082            |  | 39.5                   | 2.2  | 0.0     | 10.6    | 7.0  | 18.3 | 10.2   | 20.8    | 3.4  | 18.0    | 34.2  | 28.7 | 1.3  |
| Batch C694             |  | 10.6                   | 4.1  | 1.6     | 0.0     | 69.0 | 16.4 | 10.2   | 42.0    | 6.3  | 25.1    | 18.1  | 0.0  | 1.8  |
| Batch C709             |  | 9.4                    | 2.5  | 73.2    | 55.8    | 0.5  | 1.3  | 12.3   | 19.8    | 63.1 | 36.1    | 40.9  | 0.0  | 68.2 |
| Batch C710             |  | 8.9                    | 6.8  | 6.3     | 7.5     | 9.4  | 2.6  | 6.6    | 40.9    | 10.2 | 11.3    | 0.8   | 24.5 | 4.8  |
| Batch C711             |  | 3.2                    | 0.7  | 0.6     | 15.6    | 4.3  | 3.2  | 1.6    | 31.9    | 0.3  | 1.1     | 2.2   | 37.9 | 3.4  |
| Batch C719             |  | 117.9                  | 6.6  | 20.1    | 25.4    | 1.4  | 94.6 | 12.1   | 24.9    | 5.3  | 26.8    | 6.9   | 26.9 | 16.4 |
| Batch C729             |  | 7.4                    | 32.2 | 16.3    | 39.4    | 56.7 | 13.8 | 7.3    | 24.9    | 4.5  | 9.8     | 13.5  | 0.0  | 27.4 |
| Batch C744             |  | 1.7                    | 30.8 | 53.7    | 38.9    | 13.6 | 44.1 | 14.7   | 7.0     | 59.1 | 48.0    | 18.2  | 0.0  | 54.0 |
| Batch C746             |  | 9.7                    | 15.5 | 82.8    | 10.0    | 13.2 | 27.5 | 0.5    | 197.5 * | 1.6  | 9.1     | 23.3  | 0.0  | 1.0  |
| Batch C765             |  | 11.2                   | 14.6 | 163.5 * | 19.3    | 14.5 | 8.4  | 8.3    | 11.6    | 9.4  | 4.2     | 24.1  | 0.0  | 12.3 |
| Batch C773             |  | 6.0                    | 12.0 | 40.7    | 0.6     | 6.1  | 4.7  | 2.3    | 7.8     | 4.1  | 5.0     | 16.2  | 0.0  | 3.5  |
| Batch C774             |  | 42.1                   | 33.5 | 0.8     | 3.1     | 14.0 | 26.9 | 16.1   | 2.6     | 22.7 | 6.4     | 5.6   | 1.6  | 9.3  |
| Batch C776             |  | 42.4                   | 4.2  | 0.5     | 4.2     | 1.5  | 11.0 | 2.5    | 31.2    | 9.4  | 4.8     | 16.8  | 0.0  | 5.8  |
| Batch C780             |  | 9.9                    | 8.3  | 29.5    | 13.9    | 28.3 | 0.7  | 11.8   | 19.2    | 13.9 | 56.1    | 26.7  | 52.8 | 1.5  |
| Batch C783             |  | 14.0                   | 29.9 | 0.0     | 23.1    | 12.0 | 14.5 | 18.6   | 53.3    | 64.9 | 40.0    | 0.0   | 0.0  | 13.2 |
| Batch C784             |  | 22.2                   | 2.0  | 0.0     | 24.6    | 0.6  | 6.3  | 4.4    | 40.0    | 15.5 | 9.8     | 7.1   | 34.2 | 5.7  |
| Batch C792             |  | 19.7                   | 34.2 | 68.6    | 71.5    | 80.0 | 29.0 | 36.2   | 2.5     | 18.9 | 45.0    | 11.6  | 55.0 | 66.3 |
| Batch C798             |  | 2.7                    | 6.1  | 5.6     | 12.8    | 3.2  | 17.1 | 4.0    | 79.5    | 6.8  | 2.3     | 17.1  | 0.0  | 1.5  |
| Batch C824             |  | 46.3                   | 81.5 | 0.0     | 105.0 * | 8.1  | 18.9 | 21.8   | 61.0    | 64.4 | 30.5    | 4.2   | 8.2  | 33.4 |
| Batch C827             |  | 12.9                   | 5.7  | 0.0     | 3.7     | 26.3 | 22.4 | 15.7   | 14.8    | 9.2  | 17.7    | 1.9   | 0.0  | 26.7 |
| Batch C835             |  | 8.9                    | 7.0  | 0.0     | 30.9    | 4.4  | 6.9  | 9.2    | 16.1    | 60.4 | 7.2     | 1.5   | 12.3 | 4.8  |
| Batch C841             |  | 15.0                   | 3.9  | 3.5     | 7.8     | 10.6 | 3.9  | 2.3    | 41.8    | 0.4  | 5.3     | 3.0   | 26.8 | 4.1  |
| Batch C843             |  | 74.7                   | 10.1 | 11.4    | 33.6    | 50.8 | 37.4 | 20.4   | 10.4    | 23.3 | 35.6    | 16.6  | 0.0  | 4.1  |
| Batch C849             |  | 43.4                   | 11.1 | 48.8    | 20.6    | 15.4 | 30.5 | 20.5   | 11.1    | 32.5 | 135.1 * | 50.7  | 0.0  | 19.0 |
| Batch C871             |  | 9.5                    | 13.1 | 0.0     | 16.6    | 22.2 | 5.0  | 10.9   | 8.9     | 2.9  | 11.6    | 14.9  | 0.0  | 8.1  |
| Batch C875             |  | 2.5                    | 24.4 | 48.3    | 13.3    | 23.3 | 3.7  | 15.3   | 3.7     | 28.5 | 0.1     | 31.6  | 0.0  | 7.4  |
| Batch C879             |  | 22.8                   | 3.7  | 24.7    | 4.9     | 5.2  | 3.8  | 16.5   | 117.5   | 72.2 | 18.5    | 15.2  | 0.0  | 2.3  |
| Batch C884             |  | 55.6                   | 60.6 | 29.9    | 110.3 * | 56.6 | 47.3 | 49.3   | 2.0     | 75.4 | 100.7   | 8.4   | 0.0  | 38.7 |
| Batch C887             |  | 20.8                   | 13.4 | 0.0     | 15.4    | 12.7 | 5.7  | 3.2    | 0.0     | 42.0 | 9.6     | 27.4  | 0.0  | 16.1 |
| Batch C888             |  | 22.3                   | 29.5 | 20.4    | 45.2    | 16.4 | 24.1 | 23.8   | 89.7    | 25.4 | 42.8    | 93.0  | 50.4 | 7.8  |
| Batch C895             |  | 0.2                    | 4.7  | 1.3     | 7.4     | 30.8 | 5.8  | 3.5    | 36.0    | 5.7  | 52.5    | 19.7  | 54.6 | 3.9  |
| Batch C898             |  | 20.1                   | 8.5  | 7.0     | 33.8    | 9.7  | 15.0 | 8.3    | 85.6    | 2.2  | 72.7    | 1.7   | 3.3  | 46.8 |
| Batch C901             |  | 0.3                    | 35.2 | 0.0     | 53.7    | 1.8  | 47.6 | 31.6   | 9.1     | 43.3 | 28.1    | 20.2  | 0.0  | 9.8  |
| Batch C902             |  | 0.9                    | 6.5  | 94.0    | 15.3    | 7.6  | 7.8  | 5.1    | 188.7 * | 2.0  | 0.1     | 19.4  | 60.9 | 84.9 |
| Batch C903             |  | 0.0                    | 9.6  | 0.0     | 7.2     | 0.0  | 12.5 | 4.3    | 0.0     | 2.3  | 1.1     | 14.3  | 0.0  | 18.7 |
| Batch C906             |  | 0.5                    | 2.4  | 9.7     | 7.1     | 0.0  | 6.1  | 0.9    | 26.6    | 34.3 | 0.0     | 0.6   | 2.0  | 9.8  |
| Batch C908             |  | 93.4                   | 19.0 | 0.0     | 1.3     | 3.1  | 72.3 | 8.7    | 10.5    | 7.9  | 3.0     | 21.8  | 0.0  | 6.4  |
| Batch C925             |  | 1.9                    | 15.2 | 0.8     | 36.6    | 19.2 | 8.8  | 7.0    | 10.9    | 10.5 | 21.7    | 20.5  | 0.0  | 14.0 |
| Batch C942             |  | 67.5                   | 33.8 | 0.0     | 16.6    | 51.1 | 22.0 | 32.4   | 15.9    | 27.3 | 9.7     | 34.6  | 0.0  | 29.8 |
| Batch C945             |  | 0.0                    | 42.8 | 25.0    | 5.0     | 4.7  | 13.8 | 1.1    | 33.3    | 14.2 | 2.0     | 9.9   | 0.0  | 3.3  |
| Batch C953             |  | 14.4                   | 6.8  | 38.4    | 5.4     | 2.4  | 20.4 | 17.0   | 29.6    | 3.2  | 25.4    | 27.9  | 0.0  | 14.6 |
| Batch C954             |  | 50.8                   | 51.5 | 18.0    | 11.3    | 65.3 | 54.2 | 51.3   | 14.1    | 44.1 | 1.2     | 51.9  | 0.0  | 48.9 |
| Batch C961             |  | 55.0                   | 59.2 | 0.0     | 0.0     | 17.7 | 79.8 | 67.6   | 35.0    | 59.0 | 0.0     | 63.3  | 0.0  | 79.8 |
| Batch C962             |  | 24.0                   | 47.0 | 49.2    | 49.5    | 7.8  | 19.2 | 16.4   | 0.2     | 47.0 | 33.2    | 30.1  | 25.3 | 50.5 |
| Batch C963             |  | 13.8                   | 14.6 | 0.0     | 46.8    | 79.3 | 1.4  | 6.9    | 4.8     | 3.2  | 51.3    | 2.5   | 0.7  | 1.8  |
| Batch C970             |  | 9.3                    | 25.4 | 0.2     | 24.2    | 32.1 | 1.4  | 20.2   | 10.2    | 0.7  | 88.5    | 20.7  | 0.0  | 9.4  |
| Batch C980             |  | 0.0                    | 21.6 | 0.0     | 26.6    | 5.7  | 16.3 | 25.0   | 85.7    | 33.4 | 22.5    | 31.0  | 0.0  | 19.8 |
| Batch C986             |  | 0.0                    | 25.9 | 0.0     | 8.9     | 16.6 | 21.2 | 21.8   | 0.0     | 28.3 | 40.8    | 0.0   | 0.0  | 13.1 |
| Batch C995             |  | 14.7                   | 3.1  | 67.1    | 26.8    | 14.2 | 5.5  | 1.3    | 7.6     | 17.2 | 71.2    | 106.5 | 62.5 | 8.2  |
| Batch C996             |  | 26.9                   | 19.9 | 14.4    | 22.4    | 23.0 | 15.0 | 26.1   | 0.0     | 13.1 | 18.5    | 9.2   | 21.0 | 15.5 |

\* = Outlier based on statistical analysis of data.

TABLE 3-5: ACCURACY STATEMENT FOR WATER DATA USING THE MATRIX SPIKE

| ANALYTE   | CONFIDENCE INTERVAL | COMPLETENESS/NUMBER OF OUTLIERS | RANGE OF UNCERTAINTY (PERCENT) |
|-----------|---------------------|---------------------------------|--------------------------------|
| Arsenic   | 90%                 | 96% / Two                       | 3.57 +/- 3.35                  |
| Barium    | 90%                 | 98% / One                       | 1.03 +/- 0.62                  |
| Cadmium   | 90%                 | 100% / None                     | 1.48 +/- 2.90                  |
| Cobalt    | 90%                 | 100% / None                     | 1.04 +/- 0.34                  |
| Chromium  | 90%                 | 100% / None                     | 1.42 +/- 3.07                  |
| Copper    | 90%                 | 96% / Two                       | 1.39 +/- 5.60                  |
| Iron      | 90%                 | 93% / Three                     | 2.29 +/- 2.58                  |
| Mercury   | 90%                 | 93% / Three                     | 2.12 +/- 4.58                  |
| Manganese | 90%                 | 98% / One                       | 1.43 +/- 1.26                  |
| Nickle    | 90%                 | 100% / None                     | 1.25 +/- 1.39                  |
| Lead      | 90%                 | 100% / None                     | 3.45 +/- 2.81                  |
| Antimony  | 90%                 | 98% / One                       | 1.31 +/- 0.15                  |
| Zinc      | 90%                 | 98% / One                       | 1.62 +/- 3.57                  |

TABLE 3-6: ACCURACY STATEMENT FOR SOIL DATA USING THE MATRIX SPIKE

| ANALYTE   | CONFIDENCE INTERVAL | COMPLETENESS/NUMBER OF OUTLIERS | RANGE OF UNCERTAINTY (PERCENT) |
|-----------|---------------------|---------------------------------|--------------------------------|
| Arsenic   | 90%                 | 96% / Two                       | 4.82 +/- 3.89                  |
| Barium    | 90%                 | 96% / Two                       | 4.93 +/- 2.88                  |
| Cadmium   | 90%                 | 95% / Three                     | 4.50 +/- 3.43                  |
| Cobalt    | 90%                 | 100% / None                     | 3.26 +/- 2.74                  |
| Chromium  | 90%                 | 96% / Two                       | 4.07 +/- 3.17                  |
| Copper    | 90%                 | 93% / Four                      | 17.57 +/- 3.24                 |
| Iron      | 90%                 | 100% / None                     | NA                             |
| Mercury   | 90%                 | 95% / Three                     | 9.25 +/- 4.12                  |
| Manganese | 90%                 | 100% / None                     | 22.34 +/- 3.40                 |
| Nickle    | 90%                 | 98% / One                       | 3.59 +/- 3.57                  |
| Lead      | 90%                 | 96% / Two                       | 6.90 +/- 3.23                  |
| Antimony  | 90%                 | 100% / None                     | 6.82 +/- 2.32                  |
| Zinc      | 90%                 | 95% / Three                     | 12.46 +/- 3.13                 |

NA = Not Applicable, Overall accuracy could not be calculated for iron because all detected sample concentrations exceeded the associated matrix spike concentration by >4X.



Table 3-7 presents the percent recoveries calculated for each analyte for the water matrix, for each sample batch. Table 3-8 presents the percent recoveries calculated for each analyte for the soil matrix, for each sample batch.

### 3.3 REPRESENTATIVENESS

The objective in addressing representativeness is to assess whether the information obtained during the investigation accurately represents the site conditions. Field duplicates, laboratory blanks, and field blanks were used to assess representativeness.

#### 3.3.1 Field Duplicates

A total of 12 field duplicate pairs were submitted to the laboratory for analysis during the investigation. According to the overall number of primary groundwater samples, a minimum of six field duplicate pairs should have been submitted to the laboratory for analysis. Groundwater was the only sample matrix in which samples were split and analyzed as field duplicates by the laboratory. Groundwater was expected to exhibit less variability than the other sample media (e.g., soil, surface water, etc.). The duplicates were submitted blind to the laboratory (the duplicate samples were not identified as such to the laboratory). The relative standard deviations (RSD) of the field duplicate pairs were used to generate the overall precision for each analyte. Table 3-9 presents the overall precision for each analyte based on field duplicate results. For the overall evaluation of field precision, if a field duplicate pair provided concentration results which were both less than the detection limit, the RSD was evaluated as zero. If only one of the duplicate results was not detected and the corresponding result was a detected concentration, the detected concentration and the detection limit were used to calculate the RSD.

A higher degree of variability was expected for field duplicates than for laboratory duplicates, and they were not batch-specific; hence, the field duplicate results were not used to identify outliers. The precision results presented on Table 3-9 were based on the entire data set.

A total of 50 XRF field duplicates were analyzed during this investigation. Table 3-10 presents the overall precision of the XRF data, as indicated by the duplicate analyses. The XRF field duplicates were not split samples; rather, the same sample was analyzed twice in the field. If an XRF field duplicate pair provided concentration results which were both less than the detection limit, the RSD was evaluated as zero. If only one of the duplicate results was not detected and the corresponding result was a detected concentration, then the detected concentration and the detection limit were used to calculate the RSD.

Because a high degree of variability was expected for solid samples analyzed by the XRF, field duplicate results were not used to identify outliers. The precision results presented on Table 3-10 are based on the entire data set.



TABLE 3-7: WATER DATA ACCURACY REQUIREMENTS (% RECOVERY OF MATRIX SPIKE) AND RESULTS

|                       |  | As        | Ba        | Cd        | Co        | Cr        | Cu        | Fe        | Hg        | Mn        | Ni        | Pb        | Sb        | Zn        |
|-----------------------|--|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Required Accuracy (%) |  | 75 - 100% | 75 - 100% | 75 - 100% | 75 - 100% | 75 - 100% | 75 - 100% | 75 - 100% | 75 - 100% | 75 - 100% | 75 - 100% | 75 - 100% | 75 - 100% | 75 - 100% |
| Achieved Accuracy (%) |  |           |           |           |           |           |           |           |           |           |           |           |           |           |
| Batch C1001           |  | 101.1     | 105.2     | 100.5     | 99.7      | 95.0      | 101.3     | 99.0      | 94.0      | 101.0     | 99.3      | 106.4     | 95.6      | 102.9     |
| Batch C1009           |  | 95.6      | 103.1     | 108.6     | 101.7     | 100.2     | 100.1     | 100.6     | 106.6     | 106.6     | 102.3     | 103.6     | 96.8      | 106.7     |
| Batch C1015           |  | 103.5     | 106.1     | 108.9     | 106.2     | 104.9     | 107.8     | 89.0      | 109.4     | 109.4     | 108.4     | 101.6     | 111.4     | 110.5     |
| Batch C1023           |  | 91.6      | 98.2      | 96.0      | 95.2      | 99.3      | NA        | 61.2 *    | 89.0      | NA        | 97.8      | 92.5      | 95.1      | 103.6     |
| Batch C703            |  | 100.0     | 98.9      | 94.3      | 94.7      | 93.7      | 99.2      | 104.9     | 100.2     | 104.1     | 99.2      | 103.7     | 90.0      | 100.7     |
| Batch C705            |  | 139.9     | 94.4      | 93.2      | 93.3      | 87.9      | 95.3      | 94.4      | 96.3      | 93.9      | 94.2      | 131.3     | 92.7      | 96.5      |
| Batch C730            |  | 99.9      | 105.8     | 106.1     | 101.4     | 98.9      | 99.3      | 96.4      | 81.2      | 89.0      | 101.5     | 89.7      | 94.9      | NA        |
| Batch C732            |  | 95.6      | 110.4     | 111.8     | 105.3     | 96.8      | 108.9     | 105.5     | 95.2      | NA        | 117.0     | 98.1      | 104.9     | 144.9 *   |
| Batch C735            |  | 107.5     | 106.6     | 106.5     | 104.0     | 101.0     | 100.7     | 102.7     | 114.2     | 99.0      | 102.8     | 107.7     | 100.4     | 94.3      |
| Batch C737            |  | 110.8     | 103.7     | 98.9      | 99.1      | 97.8      | 99.8      | 117.0     | 85.7      | 103.6     | 97.7      | 96.4      | 98.4      | 104.8     |
| Batch C740            |  | 94.3      | 106.9     | 104.3     | 101.8     | 101.7     | 102.1     | 99.8      | 93.6      | 102.5     | 103.8     | 79.6      | 106.8     | 99.8      |
| Batch C742            |  | 109.6     | 100.6     | 94.1      | 97.8      | 99.0      | 98.2      | 97.5      | 100.2     | 97.3      | 97.7      | 103.4     | 91.3      | 99.0      |
| Batch C771            |  | 111.7     | 103.7     | 109.1     | 99.2      | 97.3      | 98.5      | 100.2     | 110.3     | 100.4     | 96.5      | 108.4     | 95.1      | 103.3     |
| Batch C781            |  | 104.2     | 103.8     | 94.6      | 99.0      | 96.6      | 100.3     | 99.1      | 93.7      | 98.0      | 99.3      | 100.0     | 91.6      | 99.8      |
| Batch C788            |  | 115.7     | 105.2     | 106.8     | 102.6     | 102.3     | 104.3     | 105.9     | 93.7      | 107.0     | 100.5     | 117.1     | 91.2      | 109.6     |
| Batch C813            |  | 110.2     | 149.1 *   | 102.1     | 97.6      | 101.7     | 96.5      | 101.7     | 93.7      | 100.1     | 94.2      | 116.5     | 92.7      | 90.7      |
| Batch C817            |  | 110.2     | 105.8     | 102.8     | 104.0     | 98.3      | 101.3     | 107.1     | 98.4      | 105.4     | 103.6     | 127.5     | 97.3      | 105.1     |
| Batch C818            |  | 96.7      | 103.3     | 99.4      | 100.7     | 107.3     | 98.7      | 91.2      | 86.0      | 98.9      | 99.3      | 90.6      | 93.6      | 98.3      |
| Batch C819            |  | 107.0     | 106.8     | 94.7      | 96.8      | 92.1      | 98.0      | 100.2     | 93.6      | 99.6      | 95.6      | 105.1     | 93.2      | 99.7      |
| Batch C851            |  | 93.2      | 102.3     | 102.4     | 95.6      | 94.0      | 95.9      | 35.5 *    | 87.8      | 98.1      | 100.3     | 87.5      | 94.0      | 100.4     |
| Batch C853            |  | 108.5     | 103.3     | 92.0      | 97.2      | 92.5      | 99.0      | 97.6      | 107.5     | 98.9      | 94.3      | 104.0     | 94.7      | 99.6      |
| Batch C862            |  | 136.0     | 101.6     | 99.9      | 94.6      | 90.2      | 96.7      | 104.7     | 99.0      | 106.9     | 94.1      | 112.8     | 90.0      | 101.1     |
| Batch C864            |  | 102.0     | 103.6     | 94.9      | 96.4      | 91.7      | 97.3      | 96.1      | 82.8      | 98.3      | 95.4      | 123.2     | 94.5      | 101.2     |
| Batch C866            |  | 117.1     | 108.9     | 99.3      | 103.0     | 103.7     | 105.9     | 105.4     | 97.9      | 104.2     | 102.1     | 117.7     | 99.3      | 103.8     |
| Batch C868            |  | 118.0     | 106.7     | 102.4     | 101.9     | 96.7      | 99.1      | 101.0     | 95.3      | 103.0     | 100.0     | 113.7     | 103.4     | 102.9     |
| Batch C885            |  | 98.0      | 105.5     | 90.8      | 96.5      | 92.5      | 99.5      | 97.3      | 93.2      | 98.3      | 97.0      | 96.4      | 93.9      | 100.1     |
| Batch C889            |  | 110.2     | 98.6      | 94.4      | 92.6      | 89.9      | 95.9      | 134.4     | 96.5      | 94.7      | 91.6      | 122.0     | 91.7      | 88.7      |
| Batch C896            |  | 117.4     | 93.1      | 83.6      | 88.8      | 85.7      | 89.8      | 93.3      | 96.4      | 89.8      | 88.3      | 105.5     | 84.0      | 90.0      |
| Batch C899            |  | 125.6     | 106.5     | 101.1     | 102.4     | 100.8     | 101.7     | 101.5     | 87.0      | 83.9      | 102.0     | NA        | 100.7     | 92.6      |
| Batch C904            |  | 99.6      | 103.6     | 102.8     | 98.5      | 98.6      | 97.8      | 95.6      | 89.1      | 95.9      | 96.7      | 108.2     | 93.3      | 101.3     |
| Batch C909            |  | 117.8     | 105.7     | 98.3      | 100.4     | 97.4      | 102.5     | 103.1     | -10.0 *   | 102.8     | 103.9     | 129.5     | 100.6     | 104.7     |
| Batch C912            |  | 94.0      | 105.0     | 99.5      | 102.1     | 99.7      | 72.8 *    | 51.5 *    | 91.9      | 90.9      | 102.1     | 80.8      | 97.2      | 100.0     |
| Batch C914            |  | 51.6 *    | 106.3     | 100.5     | 99.7      | 90.8      | 138.9 *   | 119.2     | 96.5      | 101.4     | 100.0     | 133.6     | 97.3      | 99.1      |
| Batch C916            |  | 84.8      | 106.5     | 104.5     | 101.9     | 100.5     | 106.3     | 105.8     | 113.7     | 103.1     | 104.5     | 101.8     | 91.0      | 102.7     |
| Batch C918            |  | 82.5      | 109.9     | 106.7     | 103.7     | 97.6      | 103.9     | 125.5     | 103.4     | 126.2 *   | 104.8     | 96.2      | 102.0     | 111.0     |
| Batch C920            |  | 95.2      | 92.8      | 90.1      | 87.6      | 82.0      | 90.7      | 86.4      | 108.6     | 87.2      | 90.1      | 110.6     | 85.0      | 92.7      |
| Batch C935            |  | 102.3     | 107.0     | 98.5      | 102.5     | 100.9     | 101.6     | 101.1     | 85.8      | 102.4     | 101.0     | 102.2     | 92.5      | 102.7     |
| Batch C937            |  | 82.5      | 106.9     | 104.7     | 103.5     | 96.3      | 104.5     | 102.0     | 101.4     | 108.1     | 108.3     | 110.4     | 101.8     | 111.7     |
| Batch C939            |  | 127.6     | 103.5     | 92.1      | 99.5      | 91.4      | 99.0      | 100.7     | 91.8      | 100.4     | 102.3     | 115.0     | 92.2      | 102.5     |
| Batch C943            |  | 103.6     | 103.7     | 98.0      | 101.1     | 91.3      | 98.6      | 96.3      | 107.8     | 101.0     | 100.6     | 89.1      | 97.1      | 98.5      |
| Batch C959            |  | 105.9     | 100.9     | 96.2      | 98.6      | 87.9      | 93.0      | 94.3      | 63.8 *    | 98.0      | 98.2      | 74.8      | 92.8      | 100.7     |
| Batch C968            |  | 98.9      | 107.5     | 105.5     | 100.5     | 92.1      | 98.1      | 99.8      | 101.9     | 100.6     | 102.7     | 123.6     | 96.4      | 102.6     |
| Batch C987            |  | 139.4     | 104.4     | 96.0      | 97.8      | 90.8      | 93.7      | 115.4     | 108.5     | 100.4     | 98.6      | 106.0     | 99.5      | 103.5     |
| Batch C991            |  | 120.5     | 106.4     | 101.6     | 101.4     | 104.0     | 100.4     | 103.4     | 108.5     | 102.4     | 99.1      | 105.7     | 92.5      | 104.1     |
| Batch C997            |  | 77.5      | 97.8      | 93.1      | 90.4      | 90.2      | 90.7      | 95.5      | 5.2 *     | 96.9      | 93.1      | 94.3      | 100.3     | 95.4      |
| Batch C999            |  | 46.7 *    | 95.4      | 91.9      | 92.4      | 82.6      | 75.3      | NA        | 99.4      | NA        | 93.0      | 83.8      | 29.4 *    | 75.5      |

NA = RECOVERY VALUE REPORTED BY LABORATORY NOT APPLICABLE FOR EVALUATION DUE TO SAMPLE CONCENTRATION EXCEEDING SPIKE CONCENTRATION BY &gt;

TABLE 3-8: SOIL DATA ACCURACY REQUIREMENTS (% RECOVERY OF MATRIX SPIKE) AND RESULTS

|                       |  | As           | Ba        | Cd        | Co        | Cr        | Cu        | Fe        | Hg        | Mn        | Ni        | Pb        | Sb        | Zn        |
|-----------------------|--|--------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Required Accuracy (%) |  | 75 - 100%    | 75 - 100% | 75 - 100% | 75 - 100% | 75 - 100% | 75 - 100% | 75 - 100% | 75 - 100% | 75 - 100% | 75 - 100% | 75 - 100% | 75 - 100% | 75 - 100% |
| Batch                 |  | Accuracy (%) |           |           |           |           |           |           |           |           |           |           |           |           |
| Batch C1003           |  | 137.4        | 131.1     | 77.1      | 121.8     | 122.3     | NA        | NA        | 178.8     | 121.0     | 127.5     | 151.9     | 62.3      | 162.9     |
| Batch C1004           |  | 134.4        | 137.2     | 98.1      | 126.4     | 121.5     | 314.5 *   | NA        | 347.4 *   | 86.2      | 127.8     | NA        | 69.0      | 164.6     |
| Batch C1005           |  | 130.2        | 153.0     | 118.9     | 112.2     | 114.2     | 129.9     | NA        | NA        | 126.5     | 118.5     | 129.4     | 119.0     | 131.8     |
| Batch C1006           |  | 88.6         | 95.9      | 96.8      | 87.9      | 90.0      | 87.7      | NA        | 154.3     | NA        | 91.1      | 102.8     | 58.0      | 169.5     |
| Batch C1007           |  | 96.0         | 100.6     | 93.1      | 93.8      | 101.9     | 99.4      | NA        | 87.8      | 136.1     | 97.7      | 92.5      | 47.8      | 103.3     |
| Batch C1008           |  | 118.9        | 93.8      | 104.2     | 111.3     | 98.0      | 108.0     | NA        | 136.8     | 80.0      | 106.8     | 103.6     | 57.8      | 108.4     |
| Batch C1022           |  | 101.4        | 95.3      | 98.9      | 95.9      | 89.2      | 92.3      | NA        | 29.0      | NA        | 97.7      | 98.6      | 59.5      | 92.0      |
| Batch C1028           |  | 122.3        | 132.0     | 97.7      | 112.9     | 121.3     | NA        | NA        | 150.8     | NA        | 122.7     | NA        | 27.1      | NA        |
| Batch C1029           |  | 91.4         | 93.4      | 90.2      | 92.1      | 87.8      | 85.4      | NA        | 82.0      | 64.1      | 94.0      | 94.3      | 37.2      | 89.6      |
| Batch C1080           |  | 88.9         | 69.7      | 54.5      | 88.7      | 42.9 *    | 83.3      | NA        | 12.2      | NA        | 14.6 *    | -7.3 *    | 59.5      | NA        |
| Batch C1082           |  | 93.5         | 96.0      | 86.8      | 87.2      | 94.6      | 93.5      | NA        | 131.8     | NA        | 88.9      | 88.5      | 20.6      | 90.0      |
| Batch C694            |  | NA           | 85.6      | 95.5      | 89.1      | 87.9      | 93.6      | NA        | 102.7     | 91.7      | 89.6      | NA        | 27.2      | 104.0     |
| Batch C709            |  | 97.6         | 63.8      | 169.1 *   | 94.7      | 85.2      | NA        | NA        | 98.0      | NA        | 96.3      | NA        | 21.9      | NA        |
| Batch C710            |  | 114.2        | 116.5     | 116.5     | 109.8     | 104.5     | 110.8     | NA        | 124.8     | NA        | 112.6     | NA        | 35.6      | NA        |
| Batch C711            |  | 98.5         | NA        | 124.8     | 89.7      | 81.1      | 76.4      | NA        | 124.8     | NA        | 92.4      | NA        | 15.5      | NA        |
| Batch C719            |  | 101.0        | 161.8     | 85.9      | 95.5      | 68.2      | 188.1     | NA        | 122.3     | NA        | 105.2     | NA        | 30.7      | NA        |
| Batch C729            |  | 97.7         | 140.3     | 70.8      | 111.5     | 134.0     | 112.2     | NA        | NA        | NA        | 103.0     | NA        | 49.8      | NA        |
| Batch C744            |  | 90.6         | 106.1     | 98.8      | 91.1      | 85.0      | 110.1     | NA        | 59.6      | NA        | 95.6      | NA        | 83.5      | NA        |
| Batch C746            |  | 84.3         | 90.5      | 75.7      | 84.1      | 82.9      | 85.8      | NA        | 111.1     | 57.5      | 85.6      | 80.1      | 68.3      | 68.1      |
| Batch C765            |  | 92.5         | 92.4      | 11.9 *    | 90.5      | 86.8      | 91.9      | NA        | 84.2      | 81.7      | 88.8      | 81.5      | 46.3      | 91.8      |
| Batch C773            |  | 102.9        | 104.5     | 90.4      | 102.8     | 98.9      | 101.3     | NA        | 98.0      | NA        | 102.6     | NA        | 51.8      | NA        |
| Batch C774            |  | 78.0         | 87.7      | NA        | 76.6      | 77.1      | NA        | NA        | 102.0     | NA        | 65.0      | NA        | 14.2      | NA        |
| Batch C776            |  | 91.2         | 98.5      | 83.9      | 87.6      | 87.6      | 85.0      | NA        | 227.3 *   | NA        | 89.1      | 81.5      | 37.8      | 96.1      |
| Batch C780            |  | NA           | 99.0      | 101.1     | 104.4     | 99.1      | 64.7      | NA        | NA        | NA        | 97.3      | 123.6     | 142.9     | NA        |
| Batch C783            |  | 124.5        | 129.2     | 114.9     | 120.0     | 117.0     | 119.9     | NA        | 159.1     | 235.5     | 120.5     | 123.9     | 100.8     | 124.8     |
| Batch C784            |  | 97.1         | 111.6     | 106.4     | 105.1     | 98.6      | 92.2      | NA        | 99.2      | NA        | 104.2     | 96.7      | 70.2      | 92.5      |
| Batch C792            |  | 166.1 *      | 94.1      | 79.8      | 90.0      | 85.6      | NA        | NA        | NA        | 37.8      | 86.0      | 169.1     | 90.2      | NA        |
| Batch C798            |  | 100.5        | 98.6      | 93.5      | 96.3      | 91.7      | 90.3      | NA        | 101.9     | NA        | 96.2      | 86.6      | 60.9      | 94.4      |
| Batch C824            |  | 151.6        | 229.1 *   | 101.9     | 100.5     | 96.4      | 2248.4 *  | NA        | 100.9     | NA        | 91.7      | NA        | 115.9     | 132.9     |
| Batch C827            |  | 113.1        | 113.5     | 101.5     | 111.2     | 106.0     | 121.6     | NA        | 68.5      | NA        | 112.1     | 139.6     | 88.5      | 116.7     |
| Batch C835            |  | -189.8 *     | 90.4      | 88.6      | 89.7      | 113.8     | 88.2      | NA        | 142.6     | NA        | 89.4      | NA        | 49.4      | 91.7      |
| Batch C841            |  | NA           | 84.0      | 84.8      | 82.0      | 73.2      | 38.5      | NA        | 102.4     | 1.6       | 79.0      | -27.3 *   | 33.7      | 398.5 *   |
| Batch C843            |  | 102.3        | 102.2     | 96.6      | 95.2      | 96.4      | NA        | NA        | 92.4      | NA        | 90.9      | 154.3     | 57.0      | NA        |
| Batch C849            |  | 89.6         | 102.3     | 131.3     | 96.4      | 81.1      | 315.4 *   | NA        | 167.3     | NA        | 63.4      | 103.3     | 65.9      | 207.1     |
| Batch C871            |  | 108.1        | 116.9     | 110.3     | 108.1     | 99.6      | 113.3     | NA        | 98.4      | 91.6      | 106.9     | 108.4     | 58.9      | 103.6     |
| Batch C875            |  | 114.6        | 121.7     | 125.0     | 115.2     | 116.4     | 116.4     | NA        | 94.8      | 125.0     | 112.1     | 118.1     | 77.6      | 112.0     |
| Batch C879            |  | 92.2         | 94.1      | 85.7      | 90.9      | 105.4     | 88.1      | NA        | 100.9     | 215.8     | 87.7      | 83.6      | 81.6      | 91.6      |
| Batch C884            |  | 79.5         | 84.3      | 85.9      | 76.1      | 48.3 *    | 72.7      | NA        | 97.5      | NA        | 77.4      | 91.6      | 66.0      | -21.3 *   |
| Batch C887            |  | 106.6        | 87.3      | 95.5      | 103.2     | 102.8     | 101.1     | NA        | 106.0     | NA        | 104.6     | 101.4     | 95.4      | 96.0      |
| Batch C888            |  | 120.7        | 132.8     | 109.8     | 117.9     | 117.0     | 126.5     | NA        | 107.2     | NA        | 116.6     | NA        | 114.0     | 168.8     |
| Batch C895            |  | NA           | 94.9      | 92.6      | 90.1      | 82.3      | 119.0     | NA        | 111.6     | NA        | 93.0      | NA        | 70.0      | 92.8      |
| Batch C898            |  | NA           | 77.5      | 81.2      | 69.5      | 69.9      | 261.9     | NA        | 71.7      | 153.9     | 66.0      | NA        | 65.2      | NA        |
| Batch C901            |  | 142.2        | 137.2     | 152.8 *   | 140.5     | 134.4     | NA        | NA        | 65.5      | 176.4     | 140.7     | 130.9     | 119.9     | 129.9     |
| Batch C902            |  | 130.3        | 131.3     | NA        | 121.9     | 128.0     | 143.7     | NA        | 96.5      | NA        | 120.5     | NA        | 94.3      | NA        |
| Batch C903            |  | 100.0        | 100.9     | 86.7      | 106.2     | 96.7      | -4.5      | NA        | 65.1      | NA        | 101.7     | 158.8     | 85.5      | 98.4      |
| Batch C906            |  | 76.6         | 104.4     | NA        | 102.8     | 105.6     | NA        | NA        | 100.3     | NA        | 104.7     | NA        | 108.1     | NA        |
| Batch C908            |  | 79.7         | 87.7      | 90.5      | 87.4      | 84.3      | 58.3      | NA        | NA        | 64.0      | 84.0      | 88.7      | 74.7      | 82.4      |
| Batch C925            |  | 87.7         | 87.1      | 92.7      | 89.6      | 86.5      | NA        | NA        | 50.2      | 13.1      | 85.5      | 68.2      | 76.6      | 76.8      |
| Batch C942            |  | 98.7         | 97.5      | 87.5      | 97.2      | 91.9      | NA        | NA        | 115.5     | NA        | 97.1      | 94.6      | 60.3      | 107.9     |
| Batch C945            |  | 77.7         | 79.0      | 68.9      | 78.8      | NA        | 78.9      | NA        | 93.5      | NA        | 104.3     | 79.8      | 5.6       | 74.9      |
| Batch C953            |  | 131.0        | 145.4     | 134.3     | 124.5     | 121.8     | 131.9     | NA        | 87.4      | NA        | 121.3     | 128.6     | 127.2     | 135.8     |
| Batch C954            |  | NA           | 153.7     | 138.7     | 134.6     | 144.9     | 388.4 *   | NA        | 94.1      | 164.0     | 131.3     | NA        | 116.8     | 260.2 *   |
| Batch C961            |  | 120.1        | 120.3     | 123.5     | 116.1     | 108.5     | 122.5     | NA        | 148.3     | 113.9     | 120.6     | 125.3     | 87.9      | 120.5     |
| Batch C962            |  | NA           | 120.7     | 93.9      | 117.2     | 113.3     | NA        | NA        | 112.3     | NA        | 121.3     | NA        | 100.1     | NA        |
| Batch C963            |  | 84.9         | 83.3      | 68.3      | 79.2      | 78.8      | 86.2      | NA        | NA        | NA        | 83.1      | 76.2      | 76.7      | 78.3      |
| Batch C970            |  | 77.9         | 109.6     | 114.9     | 106.1     | 85.7      | 133.5     | NA        | NA        | NA        | 112.0     | 95.6      | 103.5     | 216.8     |
| Batch C980            |  | 127.4        | 125.4     | 127.2     | 121.0     | 125.7     | 123.1     | NA        | 138.5     | 77.6      | 120.4     | 122.1     | 114.4     | 121.9     |
| Batch C986            |  | 100.9        | 69.1      | 88.1      | 93.6      | 82.4      | 82.7      | NA        | 131.3     | NA        | 88.5      | 96.1      | 72.6      | 78.8      |
| Batch C995            |  | 96.9         | 25.0 *    | 78.4      | 86.0      | 85.8      | NA        | NA        | 215.2 *   | NA        | 86.7      | NA        | 25.0      | 76.8      |
| Batch C996            |  | NA           | 108.7     | 138.6     | 106.0     | 99.1      | 100.1     | NA        | 93.1      | NA        | 102.0     | 115.2     | 94.9      | NA        |

NA = % RECOVERY VALUE REPORTED BY LABORATORY NOT APPLICABLE FOR EVALUATION DUE TO SAMPLE CONCENTRATION EXCEEDING SPIKE CONCENTRATION BY &gt;4X.

\* = OUTLIER BASED ON STATISTICAL ANALYSIS OF DATA

**TABLE 3-9: OVERALL PRECISION OF LABORATORY DATA  
BASED ON FIELD DUPLICATE RESULTS**

| ANALYTE   | CONFIDENCE INTERVAL | PERCENT PRECISION |
|-----------|---------------------|-------------------|
| Arsenic   | 90%                 | +/- 11.20         |
| Barium    | 90%                 | +/- 2.67          |
| Cadmium   | 90%                 | +/- 7.41          |
| Cobalt    | 90%                 | +/- 0.96          |
| Chromium  | 90%                 | +/- 10.89         |
| Copper    | 90%                 | +/- 14.82         |
| Iron      | 90%                 | +/- 10.80         |
| Mercury   | 90%                 | +/- 12.72         |
| Manganese | 90%                 | +/- 16.45         |
| Nickle    | 90%                 | +/- 8.28          |
| Lead      | 90%                 | +/- 17.79         |
| Antimony  | 90%                 | +/- 13.20         |
| Zinc      | 90%                 | +/- 15.08         |

**TABLE 3-10: OVERALL PRECISION OF XRF DATA BASED ON  
XRF FIELD DUPLICATE RESULTS**

| ANALYTE | CONFIDENCE INTERVAL | PERCENT PRECISION |
|---------|---------------------|-------------------|
| Cr(Hi)  | 90%                 | +/- 0.44          |
| K       | 90%                 | +/- 1.81          |
| Ca      | 90%                 | +/- 2.52          |
| Ti      | 90%                 | +/- 1.80          |
| Cr(Lo)  | 90%                 | +/- 1.64          |
| Mn      | 90%                 | +/- 4.09          |
| Fe      | 90%                 | +/- 2.14          |
| Co      | 90%                 | +/- 1.70          |
| Cu      | 90%                 | +/- 3.11          |
| Zn      | 90%                 | +/- 2.81          |
| As      | 90%                 | +/- 3.24          |
| Sr      | 90%                 | +/- 3.60          |
| Zr      | 90%                 | +/- 3.32          |
| Hg      | 90%                 | +/- 1.87          |
| Mo      | 90%                 | +/- 1.88          |
| Pb      | 90%                 | +/- 1.90          |
| Rb      | 90%                 | +/- 1.87          |
| Cd      | 90%                 | +/- 0.58          |
| Sb      | 90%                 | +/- 2.03          |
| Ba      | 90%                 | +/- 1.67          |
| Ag      | 90%                 | +/- 2.66          |
| U       | 90%                 | +/- 1.08          |
| Th      | 90%                 | +/- 2.34          |



### 3.3.2 Independent Analyses

A total of five solid matrix split samples were analyzed by separate laboratories during the investigation. Table 3-11 presents the overall precision calculated for each analyte when the corresponding independent laboratory data were compared. Independent laboratory analyses were not proposed in the the Final QAPjP; thus, a specific quantity of these samples was not required for the investigation. Due to the small number of samples available, independent laboratory results were not used to identify outliers; and relatively high overall precision results were expected. The precision results presented on Table 3-11 were based on the entire data set. The relatively poor overall precision calculated for manganese ( $>\pm 35\%$ ) by this comparison was attributable to a single sample providing a very poor duplicate (RSD) result. One comparison for manganese provided an RSD result of 70%, the remaining duplicate results for manganese were within the precision objective ( $\pm 35\%$  for soil) for the investigation.

### 3.3.3 Field XRF/Laboratory Analyses Comparison

A total of 659 XRF/Laboratory splits were analyzed during the investigation. Table 3-12 presents the overall precision calculated for each analyte when XRF data were compared to corresponding laboratory data. The precision results presented on Table 3-12 were based on the entire data set.

The methods of analysis and associated detection limits vary significantly between the XRF and laboratory analytical methods. The XRF analysis consistently had higher detection limits than the laboratory for all analytes. Consequently, an XRF practical quantitation limit (PQL) was determined for each analyte to provide a basis for comparison of low-range concentrations. The PQL represents the average detection limit provided by the XRF for each analyte. If the concentration reported by the laboratory was lower than the XRF PQL for the corresponding split sample, the RSD was evaluated as zero. To illustrate, if the laboratory provided a concentration of 15 mg/Kg for a specific analyte, and the XRF analytical result provided a corresponding concentration of  $<50$  mg/Kg (less than the detection limit or PQL), the RSD was zero because both concentrations were less than 50 mg/Kg. If both reported concentrations were above the PQL, then the RSD was calculated as usual.

Analytical data generated by the two different methods were compared on a sample pair basis using Pearson's linear correlation coefficient ( $r$ ). Coefficients generated using this method can range from -1 (perfect inverse linear relationship) to +1 (perfect positive linear relationship). Difficulty in the interpretation of these correlation coefficients was encountered due to a significant number of below detection limit values included in the comparison. As described above, below detection data for both analyses methods had an RSD of 0.0. A large overall number of sample pairs below the detection limit, therefore, will artificially skew the correlation coefficient. Coefficients were generated for both the entire set of paired analyses (659) and the set of pairs where one or both analyses were above the detection limit (varies for each analyte). Results of both sets of correlation

**TABLE 3-11: OVERALL PRECISION OF LABORATORY DATA  
BASED ON INDEPENDENT LABORATORY RESULTS**

| ANALYTE   | CONFIDENCE INTERVAL | PERCENT PRECISION |
|-----------|---------------------|-------------------|
| Arsenic   | 90%                 | +/- 23.08         |
| Barium    | 90%                 | +/- 29.94         |
| Cobalt    | 90%                 | +/- 25.62         |
| Chromium  | 90%                 | +/- 24.14         |
| Copper    | 90%                 | +/- 29.55         |
| Iron      | 90%                 | +/- 33.42         |
| Mercury   | 90%                 | +/- 18.95         |
| Manganese | 90%                 | +/- 42.69         |
| Nickle    | 90%                 | +/- 20.36         |
| Lead      | 90%                 | +/- 25.31         |
| Antimony  | 90%                 | +/- 21.88         |
| Zinc      | 90%                 | +/- 23.20         |

**TABLE 3-12: OVERALL PRECISION AND CORRELATION OF XRF DATA COMPARED TO LABORATORY DATA (FIELD SPLITS ANALYZED BY BOTH METHODS)**

| ANALYTE   | CONFIDENCE INTERVAL | PERCENT PRECISION | CORRELATION COEFFICIENT<br>(r) |
|-----------|---------------------|-------------------|--------------------------------|
| Arsenic   | 90%                 | +/- 2.34          | 0.8880                         |
| Barium    | 90%                 | +/- 4.12          | 0.7041                         |
| Cadmium   | 90%                 | +/- 2.06          | 0.4867                         |
| Cobalt    | 90%                 | +/- 2.01          | 0.5888                         |
| Chromium  | 90%                 | +/- 2.53          | 0.2469                         |
| Copper    | 90%                 | +/- 1.53          | 0.5703                         |
| Iron      | 90%                 | +/- 1.37          | 0.7965                         |
| Mercury   | 90%                 | +/- 1.64          | 0.3848                         |
| Manganese | 90%                 | +/- 1.95          | 0.9343                         |
| Lead      | 90%                 | +/- 1.75          | 0.8508                         |
| Antimony  | 90%                 | +/- 1.97          | 0.7187                         |
| Zinc      | 90%                 | +/- 1.83          | 0.8585                         |

coefficients are presented on Table 3-13. Elements that exhibit a significant change in the coefficient when only detected data are used (e.g. Cadmium) indicate a significant bias in analytical results; hence, a nonlinear relationship exists when all data are considered. Criteria for rejection of data are somewhat subjective; no criteria were established in the QAPjP. Analytes with a Pearson's linear correlation coefficient less than 0.7 appear not comparable to one another. The cutoff of 0.7 is based primarily on linearity considerations; a correlation coefficient less than 0.7 is beginning to exhibit a more non-linear relationship between the variables.

Evaluation of the individual analytes shows seven analytes have correlation coefficients greater than 0.7 (As, Ba, Fe, Mn, Pb, Sb, and Zn), and five analytes have correlation coefficients less than 0.7 (Cd, Co, Cr, Cu, and Hg). For the purposes of this investigation, XRF generated data for Arsenic, Barium, Iron, Manganese, Lead, Zinc, and Antimony were considered to be comparable to the laboratory generated data and were appropriate for the same intended uses as laboratory data. XRF data for Copper, Cadmium, Cobalt, Chromium, and Mercury were not comparable to the laboratory data; however, these data were usable for making relative comparisons.

### 3.3.3 Laboratory Blanks

Laboratory blanks (or sample preparation blanks) were addressed in Section 2.0, Data Validation. Laboratory contamination problems were relatively minor. No contaminants were detected above the CRDL in water preparation blank samples. Four analytes (As, Hg, Pb, and Zn) were detected above the CRDL for soil preparation blank samples. Arsenic was detected in the laboratory blank in seven separate soil sample batches; mercury, lead, and zinc were detected in one sample batch each. If a contaminant was detected in the laboratory preparation blank, all concentrations for the entire batch for that analyte were flagged "J".

### 3.3.4 Field Blanks

A total of seven field blank samples were collected for laboratory analysis during the investigation. According to the overall number of primary groundwater samples collected, a minimum of six field blanks should have been submitted to the laboratory for analysis. The blank samples were collected using de-ionized water placed in the standard sample containers while in the field, and preserved as an actual sample; the blank samples were submitted blind to the laboratory (the samples were not identified as field blanks). Field blanks were used to assess possible sample contamination due to field conditions: airborne contaminants entering the sample media during sampling, sample containers becoming contaminated, contaminants introduced due to field sampling procedures or preservatives, etc.

Only two analytes were detected in the field blank samples slightly above the CRDL during the investigation: manganese in one sample and lead in another. However, the lead contamination was also detected in the corresponding laboratory preparation blank



**TABLE 3-13: CORRELATION COEFFICIENTS FOR XRF  
DATA COMPARED TO LABORATORY DATA**

| ANALYTE   | ALL PAIRED DATA CONSIDERED |                          | ABOVE DETECTION DATA CONSIDERED |                          |
|-----------|----------------------------|--------------------------|---------------------------------|--------------------------|
|           | n<br>(# of sample pairs)   | r<br>(correlation coef.) | n<br>(# of sample pairs)        | r<br>(correlation coef.) |
| Arsenic   | 659                        | 0.8880                   | 528                             | 0.8854                   |
| Barium    | 659                        | 0.7041                   | 641                             | 0.7027                   |
| Cadmium   | 659                        | 0.4867                   | 106                             | 0.8750                   |
| Cobalt    | 659                        | 0.5888                   | 72                              | 0.5899                   |
| Chromium  | 659                        | 0.2469                   | 147                             | 0.4506                   |
| Copper    | 659                        | 0.5703                   | 517                             | 0.5624                   |
| Iron      | 659                        | 0.7965                   | 659                             | 0.7965                   |
| Mercury   | 659                        | 0.3848                   | 54                              | 0.3654                   |
| Manganese | 659                        | 0.9343                   | 578                             | 0.9340                   |
| Lead      | 659                        | 0.8508                   | 575                             | 0.8455                   |
| Antimony  | 659                        | 0.7187                   | 218                             | 0.6997                   |
| Zinc      | 659                        | 0.8585                   | 640                             | 0.8581                   |

at just below the CRDL, indicating possible laboratory-derived contamination. The samples potentially affected by the slight lead and manganese blank contamination (as indicated by the field blanks) have also been flagged "J".

### 3.3.5 Summary

In summary, the laboratory preparation blanks and field blank samples indicated that no significant contamination entered the investigation derived samples via environmental, preservative, or sample container contamination. Some minor contamination was likely attributable to the laboratory; however, Pioneer concludes these quality control data indicate that the analytical results were representative.

The only method available to address the representativeness of the XRF-generated data was to compare them to the corresponding laboratory data which were determined to be representative. For the purposes of this investigation, XRF generated data for As, Ba, Fe, Mn, Pb, Zn, and Sb were considered to be comparable to the laboratory generated data; therefore, XRF data for these seven analytes were also determined to be representative.

### 3.4 COMPLETENESS

The objective in addressing completeness is to assess whether enough of the data collected are valid to meet the needs of the investigation. Completeness for each analyte is typically assessed by comparing the number of valid sample batches to the total number of batches analyzed by the laboratory. However, although limitations were applied to some of the laboratory data compiled during this investigation (i.e. flagged data), and a small portion of the data were evaluated as outliers, none of the data were flagged "R" or were considered otherwise unusable. Therefore, 100% of the laboratory data were considered valid for the completeness determination. However, the limitations of the data should be considered when making interpretations.

### 3.5 COMPARABILITY

The objective in addressing comparability is to assess whether one set of data can be compared to another set of data. Comparability was assessed by determining if EPA-approved analysis methods were used, if the concentration values and units reported were appropriate for the database, if specific sampling locations can be established and documented, and if field collection methods were similar.

The field investigation and laboratory analyses followed QA/QC procedures as outlined in the QAPjP and Field Sampling Plan for all media and all analytical methods. The concentration values and units reported by the laboratory were all appropriate for the database and were generated using standard operating procedures. All sampling locations were documented in field log books and on sample location maps; and all field collection methods followed the Field Sampling Plan and standard operating procedures. Consequently, the data were considered comparable.

#### **4.0 SUMMARY AND CONCLUSIONS**

The analytical data generated by this investigation were assessed via comprehensive validation and evaluation procedures according to guidelines developed by the U.S. EPA, where appropriate. Overall precision, accuracy, representativeness, comparability, and completeness of the data were assessed to determine compliance with the data quality objectives (DQOs) outlined in the Final Quality Assurance Project Plan (QAPjP) for the Abandoned Mines Hazardous Materials Inventory. Although limitations were applied to some of the data, and a small portion of the data were evaluated as outliers, none of the data were flagged "R" or were considered otherwise unusable. Consequently, 100% of the laboratory data compiled during this investigation were considered valid.

Pioneer concludes that the soil and water inorganic data provided by the laboratory meet the DQOs outlined in the QAPjP. CLP SOW analytical methods were utilized which provided analytical support Level IV data. Additionally, evaluation of the individual analytes shows that XRF generated data for seven analytes (As, Ba, Fe, Mn, Pb, Sb, and Zn) were considered to be comparable to the laboratory generated data and were appropriate for the same intended uses as laboratory data. However, the limitations of the laboratory and XRF data should be considered when making interpretations.

#### **5.0 REFERENCES**

- Pioneer, 1993a. Sampling and Analysis Plan for the Abandoned Mines Hazardous Materials Inventory.
- Pioneer, 1993b. Laboratory Analytical Protocol for the Abandoned Mines Hazardous Materials Inventory.
- U.S. Environmental Protection Agency, 1990. Contract Lab Program, Statement of Work. Inorganic Analysis, Multi-Media, Multi-Concentration. March 1990.
- U.S. Environmental Protection Agency, 1988. Laboratory Data Validation, Functional Guidelines for Evaluating Inorganics Analysis. July 1, 1988.

## **APPENDIX A**

### **PROCEDURES FOR CALCULATING ACCURACY AND PRECISION**





## PROCEDURES FOR CALCULATING ACCURACY

1. Calculate the percent recovery of the lab matrix spike:

$$\% \text{ Recovery of Spike} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

where:

SSR = Spiked Sample Results;  
SR = Sample Results; and  
SA = Spike Added.

Perfect accuracy would be 100 percent recovery.

2. Calculate the standard deviation of all pairs.

$$SD = \left[ \frac{\sum_{i=1}^n (\text{Recovery}_i - \text{Recovery}_{\text{avg.}})^2}{n-1} \right]^{1/2}$$

where:

Recovery<sub>i</sub> = individual recoveries;  
Recovery<sub>avg.</sub> = average recovery; and  
n = number of values.

3. To validate recovery data, the individual recoveries are compared with the average recovery value to identify individual values that lie outside the range of reasonableness. Chauvenet's criterion is used to identify individual recovery values that lie outside the range. To use Chauvenet's criterion, the screening variable is computed for recovery values that are suspected of lying outside the range of reasonableness.

$$\text{Screening Variable} = (\text{Recovery}_i - \text{Recovery}_{\text{avg.}}) / SD.$$

The calculated screening variable is then compared to the maximum allowable value (found in Table A-1, Chauvenet's Criterion) for the appropriate number of recovery determinations. The suspect recovery value is set aside (set aside values are called outliers) if the calculated screening variable equals or exceeds the maximum allowable value.

**TABLE A-1**  
**CHAUVENET'S CRITERION**  
**FOR REJECTING A SUSPECTED VALUE<sup>a</sup>**

| Number of Samples<br>n | Maximum Allowable Values for<br>(Recovery <sub>i</sub> - Recovery <sub>avg</sub> ) / SD <sup>b</sup> |
|------------------------|--|
| 3                      | 1.901  |
| 4                      | 1.983  |
| 5                      | 2.015  |
| 6                      | 2.111  |
| 7                      | 2.164  |
| 8                      | 2.195  |
| 9                      | 2.214  |
| 10                     | 2.228  |
| 11                     | 2.279  |
| 12                     | 2.318  |
| 13                     | 2.348  |
| 14                     | 2.373  |
| 15                     | 2.393  |
| 16                     | 2.409  |
| 17                     | 2.424  |
| 18                     | 2.435  |
| 19                     | 2.445  |
| 20                     | 2.454  |
| 21                     | 2.462  |
| 22                     | 2.469  |
| 23                     | 2.475  |
| 24                     | 2.480  |
| 25                     | 2.485  |
| 26                     | 2.502  |
| 27                     | 2.517  |
| 28                     | 2.530  |
| 29                     | 2.543  |
| 30                     | 2.555  |
| 40                     | 2.634  |

<sup>a</sup> Based on t distribution rather than the traditional (normal) distribution.

<sup>b</sup> Individual Recovery = Recovery<sub>i</sub>  
Average Recovery = Recovery<sub>avg</sub>.

If outliers are identified using Chauvenet's criterion, a new average recovery and a new standard deviation are recalculated using the remaining good value, and Chauvenet's criterion is reapplied. This procedure is repeated until all surviving recovery values pass Chauvenet's criterion. (Usually one application and one recalculation are enough.) The final average recovery and final standard deviation are calculated from the surviving recovery values. The final average recovery value is used to eliminate any bias from the laboratory data.

4. The range of uncertainty (R) in the recovery is then calculated.

$$pR = p \text{ tSD}/(n)^{1/2}$$

where:

R = range of uncertainty expressed as a percent;  
t = value of the t distribution for the selected  
confidence level (90 percent) and (n-1) degrees of freedom (Table A-2);  
n = number of samples; and,  
SD = standard deviation.

The range of uncertainty is used in conjunction with the average recovery to determine if bias adjustments are required.

5. The completeness of accuracy data is that percentage of the total number of samples that remained after outliers are identified and set aside with Chauvenet's criterion.







**TABLE A-2**  
**DISTRIBUTION OF t**

| Number<br>of<br>Sample | Degrees<br>of<br>Freedom | 90% Complementary Probability |
|------------------------|--------------------------|-------------------------------|
| 2                      | 1                        | 6.314                         |
| 3                      | 2                        | 2.920                         |
| 4                      | 3                        | 2.353                         |
| 5                      | 4                        | 2.132                         |
| 6                      | 5                        | 2.015                         |
| 7                      | 6                        | 1.943                         |
| 8                      | 7                        | 1.895                         |
| 9                      | 8                        | 1.860                         |
| 10                     | 9                        | 1.833                         |
| 11                     | 10                       | 1.812                         |
| 12                     | 11                       | 1.796                         |
| 13                     | 12                       | 1.782                         |
| 14                     | 13                       | 1.771                         |
| 15                     | 14                       | 1.761                         |
| 16                     | 15                       | 1.753                         |
| 17                     | 16                       | 1.746                         |
| 18                     | 17                       | 1.740                         |
| 19                     | 18                       | 1.734                         |
| 20                     | 19                       | 1.729                         |
| 21                     | 20                       | 1.725                         |
| 22                     | 21                       | 1.721                         |
| 23                     | 22                       | 1.717                         |
| 24                     | 23                       | 1.714                         |
| 25                     | 24                       | 1.711                         |
| 26                     | 25                       | 1.708                         |
| 27                     | 26                       | 1.706                         |
| 28                     | 27                       | 1.703                         |
| 29                     | 28                       | 1.701                         |
| 30                     | 29                       | 1.699                         |
| 31                     | 30                       | 1.697                         |
| 41                     | 40                       | 1.684                         |
| 61                     | 60                       | 1.671                         |
| 121                    | 120                      | 1.645                         |

## PROCEDURES FOR CALCULATING PRECISION

1. Calculate the relative percent difference (RPD) of each replicate pair:

$$RPD = \frac{|S-D|}{(SD)/2} \times 100$$

where:

RPD = relative percent difference;  
 S = first sample value (original); and  
 D = second sample value duplicate.

Perfect precision would result in 0 percent RPD.

2. Any RPD value exceeding the control limit of  $\pm 20$  percent (water) or  $\pm 35$  percent (soil) for inorganics or the control limits in the QAPjP for organics is evaluated as an outlier using the Dixon Q method.

### Dixon Test for Outlying Observations

This procedure has an advantage in that an estimate of the standard deviation is not needed to use it. The procedure is:

- a. rank the RPD data in order of increasing numerical value;
- b. decide which RPD value is suspect (usually the highest number);
- c. select the risk for a false rejection (Table A-3); and
- d. compute one of the following ratios (statistics):

| n                   | Ratio | If $X_n$ is suspect             |
|---------------------|-------|---------------------------------|
| $3 \leq n \leq 7$   | r10   | $(X_n - X_{n-1}) / (X_n - X_1)$ |
| $8 \leq n \leq 10$  | r11   | $(X_n - X_{n-1}) / (X_n - X_2)$ |
| $11 \leq n \leq 13$ | r21   | $(X_n - X_{n-2}) / (X_n - X_3)$ |
| $14 \leq n \leq 25$ | r22   | $(X_n - X_{n-2}) / (X_n - X_4)$ |

- e. compare the ratio (statistic) calculated with the values in Table A-3. If the calculated ratio is greater than the tabulated value, rejection may be made with the tabulated risk.
- f. Suspected outliers failing the Dixon test are rejected in an iterative process and are not used in the following precision QA statement calculations.



TABLE A-3

## VALUES FOR USE IN THE DIXON TEST FOR OUTLIERS

| Statistic | Number of<br>Observations, n | 10% Risk of False Rejection |
|-----------|------------------------------|-----------------------------|
| t 10      | 3                            | .886                        |
|           | 4                            | .679                        |
|           | 5                            | .557                        |
|           | 6                            | .482                        |
|           | 7                            | .434                        |
| t 11      | 8                            | .479                        |
|           | 9                            | .441                        |
|           | 10                           | .409                        |
| t 21      | 11                           | .517                        |
|           | 12                           | .490                        |
|           | 13                           | .467                        |
| t 22      | 14                           | .492                        |
|           | 15                           | .472                        |
|           | 16                           | .454                        |
|           | 17                           | .438                        |
|           | 18                           | .424                        |
|           | 19                           | .412                        |
|           | 20                           | .401                        |

Original reference: W.J. Dixon, "Processing Data Outliers," Biometrics, B10MA, 9(No.1): 74-89 (March 1953).

3. Calculate the relative standard deviation (RSD) of each replicate pair.

$$RSD_{\text{each pair}} = \text{SD each pair} / \text{Mean}$$

4. Calculate the RSD for all the pairs.

$$RSD_{\text{overall}} = \left[ \frac{\sum_{i=1}^n (RSD_{\text{each } i})^2}{n-1_{\text{pair}}} \right]^{1/2}$$

5. Calculate precision as a percent.

$$\text{Precision}(\%) = \left[ \frac{t_{(n-1)} \times RSD_{\text{overall}}}{(n-1)^{1/2}} \right] \times 100$$

Where t is the value from the 90 percent probability level (Table A-2).

6. The completeness of precision data is that percentage of the total number of RPD values that remained after outliers identified and set aside with Dixon's Q ratio.



**FINAL**  
**SAMPLING AND ANALYSIS PLAN**  
**FOR THE**  
**ABANDONED MINES**  
**HAZARDOUS MATERIALS INVENTORY**

**Abandoned Mine Reclamation Bureau**  
**Montana Department of State Lands**  
**1625 11th Avenue**  
**Helena, Montana 59620**

**AUGUST 1993**





**FINAL**  
**SAMPLING AND ANALYSIS PLAN**  
**FOR THE**  
**ABANDONED MINES HAZARDOUS MATERIALS INVENTORY**

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## 1.0 INTRODUCTION

This document was prepared for the Montana Department of State Lands/Abandoned Mines Reclamation Bureau (MDSL/AMRB) by Pioneer Technical Services, Inc., (Pioneer) and Thomas, Dean & Hoskins, Inc., (TD&H) under the Engineering Services Agreement DSL-AMRB No.004 for FY92/93. This Sampling and Analysis Plan (SAP) presents the sampling approach for the Abandoned Mines Hazardous Materials Inventory. This SAP also contains instructions on completing the Inventory Form and the Standard Operating Procedures (SOPs) for conducting the field sampling activities. This SAP is a supporting document to be used in conjunction with the Quality Assurance Project Plan (QAPjP) that describes quality assurance procedures for the field and lab data for the project (Pioneer, 1993a), the Laboratory Analytical Protocol (LAP) that describes laboratory requirements for the project (Pioneer, 1993b), and the Health and Safety Plan that describes practices and procedures to minimize exposure to hazardous materials and to eliminate any possibility of physical injury (Pioneer, 1993c).

### 1.1 PROJECT OBJECTIVE

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 and the Superfund Amendments and Reauthorization Act (SARA) of 1986 give the U.S. Environmental Protection Agency (EPA) the authority to control the actual or potential release of hazardous substances which pose a substantial threat to the public or the environment. The goal of the Abandoned Mines Hazardous Materials Inventory is to determine if there are substances present that pose a threat to human health or the environment through evaluation of existing data and site characterization (collection of chemical and physical data). Approximate volumes of hazardous materials sources will be determined and migration pathways will be evaluated. Data pertinent to reclamation planning will also be collected.

### 1.2 PROJECT DESCRIPTION

The Abandoned Mines Hazardous Materials Inventory includes approximately 270 sites in 23 counties throughout Montana. The topography will range from gently sloping land in floodplains to very steep, high elevation, mountainous areas. The land has been identified as public lands (U.S. Department of Agriculture/Forest Service, U.S. Department of Interior/Bureau of Land Management, Montana Department of State Lands, etc.) or patented lands (private ownership). The project consists of inactive/abandoned mine sites; however, exploration activities may be in progress at some of the sites.

Significant features at each of the sites may include tailings ponds, impoundments, and piles; waste rock dumps or piles; mine adits, pits, shafts, and dumps; miscellaneous buildings (and



associated asbestos) and structures; roads; chemical or fuel storage (barrels or tanks); fencing; and, miscellaneous power supply items (poles, transformers, lines, etc.). The sites may support wildlife, domestic grazing, or aquatic life. Residential occupation of the sites is not expected, but residences may be present adjacent to the sites.

### 1.3 INVESTIGATION APPROACH

Due to the number of sites to be investigated during this program and the similarity in characteristics and waste types at many of the sites, a site-specific standard inventory form has been developed to direct the investigation at each site. The use of the inventory form is discussed in Section 2.0 and Appendix A.

### 2.0 SITE-SPECIFIC INVENTORY FORM

The site-specific inventory form is a method for a systematic approach to evaluating existing site data, directing field activities and recording field data collected during the site characterization. The site-specific inventory form will serve a similar function as the Field Sampling Plan (FSP) typically generated for CERCLA Preremedial and Remedial Investigations.

Instructions on properly completing the site-specific inventory form are presented in Appendix A. The use of the form ensures efficiency, continuity and comparability are achieved from site to site and between each of the field teams.

Existing site data is compiled and placed on the form prior to field activities. Information such as names, locations, mine type, ore body characteristics, status, ownership, analytical data, well logs, surface water use, and site features is entered. This information will come from photos, historical reports, existing analytical data, and databases that are available from the AMRB and other agencies. Also, a base map will be prepared from existing sketches and topographic maps prior to field activities when this information is available.

The form requires input on waste characteristics including source types, sizes, locations, and containment; acid mine drainage potential including presence of sulfides; groundwater characteristics including field measurements, approximate depth to water, distance to nearest well, and flowing adits; surface water characteristics including field measurements, flow approximations, sedimentation, wastes in floodplains, importance of the aquatic environment and presence of wetlands; air pathway characteristics including vegetative cover and waste material grain size; direct contact characteristics including access; and, safety characteristics including openings, highwalls, and structures.

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### 3.0 SITE CHARACTERIZATION

The field team leader will direct the collection of samples for laboratory analysis and field X-Ray Fluorescence (XRF) analysis using the logic detailed in the following subsections for each medium to be sampled. The Field SOPs are presented in Appendix B. The SOPs detail methodology for sampling and field analysis activities. Appendix C provides an equipment list to be used by each field team for conducting the investigations.

#### 3.1 GROUNDWATER

Although no monitoring wells will be installed for this program, impacts to groundwater quality may be observed and quantified at many of the sites by sampling groundwater discharge from mine workings, natural springs or seeps, existing monitoring wells or domestic wells in close proximity to the site.

##### 3.1.1 Discharge From Mine Workings, Springs, or Seeps

Groundwater discharging from mine openings such as adits, shafts, or air vents as well as natural springs or seeps shall be sampled as close to the point of discharge as safely practical. Discharging water will be sampled as surface water due to difficulties associated with obtaining a sample prior to contact with ambient air. Grab water samples shall be collected for total metals, anions (chloride, Nitrate/Nitrite, and Sulfate), hardness, and Total Dissolved Solids (TDS). The total metals analysis may be specified as either the complete Total Analyte List or a short-list based on historical source information such as previous analyses and/or source ore body characterizations as well as information obtained during the investigation (see Section 3.3.2). The typical short-list will include the following metals: Antimony, Arsenic, Barium, Cobalt, Cadmium, Chromium, Copper, Iron, Mercury, Manganese, Nickel, Lead, and Zinc. This analytical selection logic also applies to the remainder of Section 3.1 and Section 3.2.

Field parameters to be measured shall include flow rate, pH, Eh, temperature, specific conductance, and alkalinity.

##### 3.1.2 Shaft Sampling

A depth sounding probe shall be lowered into open shafts. If water is present in the shaft within 100 feet of the surface, a grab sample will be collected using a bailer. Water will be obtained from a minimum of 10 feet below the static water level when possible. Disturbance to the water column shall be minimized. Grab water samples shall be collected for dissolved metals (field filtered), anions, hardness, and TDS. Field parameters shall include pH, Eh, temperature, specific conductance, and alkalinity.



### 3.1.3 Monitoring/Domestic Wells

If monitoring wells are present on or near the site (installed for the purpose of monitoring groundwater from the site), the well(s) will be sampled using a bailer following proper purging of the well (extraction of three casing volumes or until pH, specific conductance and temperature stabilize). Static water level shall be measured prior to purging. Grab water samples shall be collected for dissolved metals (field filtered), anions, hardness, and TDS. Cyanide analyses will be added if cyanide leaching was conducted at that particular site. Field parameters shall include pH, Eh, temperature, and specific conductance.

If domestic wells are present within 1/4 mile downgradient of the site, at least one well will be sampled, provided permission can be obtained from the landowner. Static water level shall be measured prior to purging the well. Samples will be collected using the dedicated pump at the tap nearest to the pump or using a properly deconned bailer, following proper purging of the well (extraction of three casing volumes or until pH, specific conductance and temperature stabilize). Grab water samples shall be collected for total metals (due to potential use as drinking water), anions, hardness, and TDS. Cyanide analyses will be added if cyanide leaching was suspected on-site. Field parameters shall include pH, Eh, temperature, specific conductance, and alkalinity.

## 3.2 SURFACE WATER

### 3.2.1 Flowing Streams

When live streams are present adjacent to a site, flowing through a site, or within a direct runoff flow path of a site, stream samples will be collected upgradient and downgradient of the potential source area. If multiple sources are present within the drainage, then samples shall be collected downgradient of the probable point of entry for each source to distinguish potential impacts from each potential source. Stream water samples will be paired with sediment samples in order to mitigate the potential for high flow dilutions of contaminant concentrations and give a more historical view of contaminant migration.

If large streams or rivers with flows greater than approximately 500 cfs or flows greater than 500 times the flow rate of the source discharge are present, then sediment samples will be collected upgradient and downgradient of the probable point of entry for each potential source. Field water quality parameters including pH, specific conductance, and alkalinity will be measured. Water samples will be collected if field parameters indicate a measurable impact to the water quality. If the field parameter measurements remain constant upgradient and downgradient, then only sediment samples will be collected due to the large dilution effect from the stream or river.

### 3.2.2 Dry Intermittent Drainages

When dry intermittent drainages are present adjacent to a site or bisecting a site that potentially receives runoff from the site, sediment samples will be collected upgradient and downgradient of the probable point of entry for each potential source in the drainage(s) in order to determine if contaminant releases have occurred during past flow events.

### 3.3 MILL TAILINGS

#### 3.3.1 Sampling for XRF Analysis

Sampling and XRF analysis will be conducted on sites with mill tailings to assist in locating proper sampling locations for laboratory (lab) analyses and characterizing the extent or volume of the mill tailings. Samples will be collected to determine the areal and depth related variations in metals concentrations.

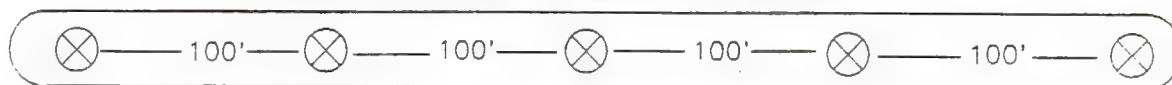
The tailings will be sampled at two to several locations depending on the size of the tailings impoundment. Figure 1 has been prepared to provide guidance of the number of sample locations necessary based on the size of the deposit. The exact number and location of sample locations will be left to the discretion of the field team leader.

A vertical profile must be obtained at each sample location to determine whether the tailings deposited were of a consistent nature or varied due to changes in the milling process or ore source. A hand soil auger will be used to obtain a vertical profile of the mill tailings deposit at each sample location to a depth of 15 feet. The contents of each auger bucket shall be spread out sequentially on a plastic sheet as it is removed from the auger hole. Samples for XRF analysis will be collected from each distinct zone that tailings texture or color changes as well as from the underlying soil. If no apparent change in color or texture occurs, XRF samples should be collected every three to five feet to verify the mill tailings are homogeneous within the deposit. When total depth of the deposit is less than 15 feet, the bore hole(s) shall penetrate the underlying soils when soil conditions allow and a sample shall be collected to determine whether metals are migrating from the tailings.

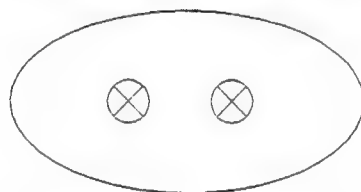
An XRF subsample must be taken from each borehole at 0 to 2 feet to evaluate the air pathway risk as well as the soil exposure risk. Visually evident releases of tailings to the air due to winds shall be photo-documented when possible.

Sediment samples will also be collected at the surface (0 to 3 inches) from drainages in downgradient directions from the mill tailings deposit to determine whether mill tailings are migrating. The field team leader will select sample locations in migration

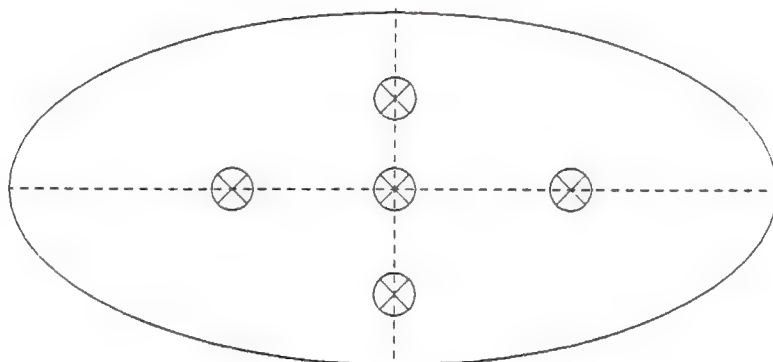
TAILINGS DEPOSITED IN DRAINAGE CHANNELS



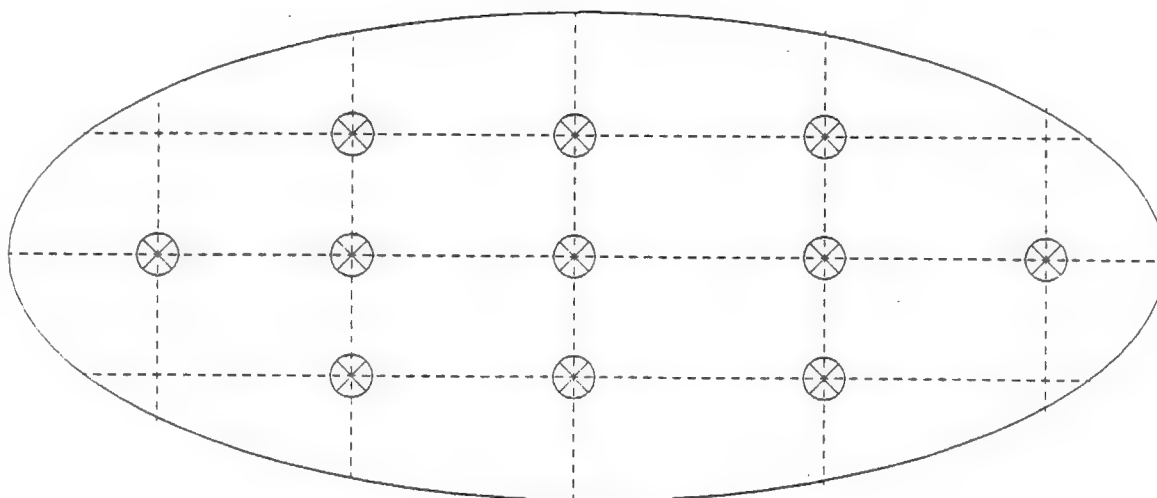
TAILINGS IMPOUNDMENTS



0 - 0.5 ACRES



0.5 - 5.0 ACRES



5 - 50 ACRES

⊗ APPROXIMATE BOREHOLE LOCATION

0.5 ACRES = 21,750 SQ. FT.  
 1.0 ACRES = 43,500 SQ. FT.  
 5.0 ACRES = 217,500 SQ. FT.  
 10.0 ACRES = 435,000 SQ. FT.  
 50.0 ACRES = 2,175,000 SQ. FT.

FIGURE 2  
 SUBSAMPLE LOCATION GRID  
 FOR MILL TAILINGS





pathways (solid matrix only) that originate from a source. If a drainage pathway is evident, the sample locations are to be selected at the discretion of the field team leader; typically 500 and 1,000 feet from the source.

### 3.3.2 Sampling for Laboratory Analyses

The results of the field XRF analysis will be used to assist the field team leader in selecting the location and number of samples to be submitted for lab analyses. Relative differences in metals concentrations from XRF analysis will be reviewed to determine the most suitable subsample locations for obtaining a representative composite sample. More than one composite sample may be necessary if XRF results indicate distinctly different source material zones (either horizontal or vertical).

The XRF analysis will also be used to select the optimal location for collecting a lab sample that could potentially be used to document an offsite release.

Samples will be collected for the following analyses: total metals, acid base accounting, and cyanide if historical accounts or on-site evidence indicate it may have been used. The total metals analysis may be specified as either the complete Total Analyte List or a short-list based on historical information such as previous analyses and/or source ore body characterizations as well as the XRF analysis results. The typical short-list will include the following metals: Antimony, Arsenic, Barium, Cobalt, Cadmium, Chromium, Copper, Iron, Mercury, Manganese, Nickel, Lead, and Zinc. Cation exchange capacity and particle size analysis by hydrometer may also be specified when site conditions (such as isolation from groundwater, absence of surface water in the drainage, and relatively low metals concentrations) indicate that in-place stabilization to the mill tailings is feasible.

The field parameters to be measured will include pH, moisture content, texture, and radioactivity as per the SOPs (Appendix B).

## 3.4 WASTE ROCK DUMPS

### 3.4.1 Sampling for XRF Analysis

Representative sampling of waste rock dumps is extremely difficult. The large size of most dumps as well as the coarse nature of most dump material typically allows only near-surface samples to be collected.

When dumps visually appear to be composed of wastes from one source (i.e., uniform size and color), then one composite sample of the dump will probably be sufficient. Field XRF analyses of several of the composite subsamples should be performed to verify the similarity of the material being composite. The composite



subsamples should be taken below the typical oxidation zone (typically 1 to 2 feet below surface) in order to obtain representative metals concentrations. Subsamples will be located on the sides of the dump where safe footing can be obtained. Two to six locations should be identified around the circumference of the dump at the discretion of the field team leader. A pickax or shovel will be used to excavate one to two feet into the side of the dump prior to collecting the subsample.

#### 3.4.2 Sampling for Laboratory Analyses

The results of the field XRF analysis will be used to assist the field team leader in selecting the location and number of samples to be submitted for lab analyses. Relative differences in metals concentrations from XRF analysis will be reviewed to determine the most suitable subsample locations for obtaining a representative composite lab sample. More than one composite sample may be necessary if XRF results indicated distinctly different source material zones.

The XRF analysis will also be used to select the optimal location for collecting a lab sample that could possibly document a offsite release.

Sampling will be collected for the following analyses: total metals, and acid base accounting. The total metals analysis may be specified as either the complete Total Analyte List or a short-list based on historical information such as previous analyses and/or source ore body characterizations as well as the XRF analysis results. The typical short-list will include the following metals: Antimony, Arsenic, Barium, Cobalt, Cadmium, Chromium, Copper, Iron, Mercury, Manganese, Nickel, Lead, and Zinc.

The XRF subsamples taken within two feet of the surface will be sufficient to evaluate the air pathway risk as well as the soil exposure risk.

Field Parameters to be measured will include pH, moisture content, texture, and radioactivity as per the SOPs (Appendix B).

#### 3.5 HEAP LEACH PADS

Inactive heap leach pads shall be sampled to determine residual metals and cyanide concentrations in the material present. One multiple-point composite sample will be collected from 2 to 3 feet from the bottom of the heaped material by digging into the toe of the pile. Care must be taken to avoid puncturing liner systems if present.

If free liquid is present at either the contact between the liner and the heap pile or in storage ponds adjacent to the pad, a water sample will be collected for total metals and cyanide analysis.

At least one adjacent soil sample will be collected from the down-slope side of the pile to determine whether a release of metals or leaching solution has occurred. This sample will be analyzed for total metals and cyanide.

### 3.6 PLACER WORKINGS

The primary concerns associated with placer workings include increased sediment loading to the watershed and mercury contamination due to past amalgamation activities. Several subsamples shall be collected in fine-grained materials at the base of the placer piles, preferably at bedrock contacts, in order to assess whether mercury contamination has occurred. In addition, stream water and sediment samples shall be collected upgradient and downgradient when applicable.

### 3.7 OTHER MILL WASTES/ASBESTOS

Mill reagents or other materials may be sampled at the discretion of the field team leader if the material is unidentifiable, and in large enough quantities to represent a potential environmental threat. Sealed barrels or drums of mill wastes will not be opened unless contents can be readily identified by appropriate labeling. Recourse Conservation and Recovery Act (RCRA) characteristic waste tests may be necessary to determine potential future special handling requirements if significant volumes of unidentifiable materials are present.

White or off-white fibrous insulation material should be sampled to determine whether asbestos is present. One sample composite from the site is sufficient.

### 3.8 BACKGROUND SAMPLING

One background soil sample must be collected for metals analysis to establish that source concentrations are higher than background. The sample shall be a surficial (0 to 6 inches) grab sample located within an area of similar rock or soil type and upgradient to the site. Background samples may be applied to multiple sites in close proximity in order to reduce analytical costs.

## 4.0 SAMPLING PROTOCOL

### 4.1 FIELD PROCEDURES

All field activities, including: sampling and analytical methods; sample preservation; quality assurance/quality control (QA/QC) samples and procedures; equipment and personnel decontamination; sample designation and handling; and, documentation will follow SOPs outlined in Appendix B.

#### 4.1.1 Equipment Decontamination

All equipment will be decontaminated before sampling. Equipment decontamination consists of a tap water rinse, a soap and tap water wash, a dilute nitric acid ( $\text{HNO}_3$ ) rinse (10 parts distilled/deionized (DI) water to 1 part concentrated  $\text{HNO}_3$ ), and a DI water rinse followed by air drying. All equipment will also be decontaminated before leaving the site to prevent off-site transport of contaminants.

#### 4.1.2 Sample Designation and Labeling

A sample numbering system will be used to identify the project site, the sample medium, and the specific sample location:

Sample number: 22-072-GW-1

AMRB PA No.: Hyphenated five digit number unique to each site.

Media:

- GW - Groundwater
- SE - Sediment (Surface Water Body)
- TP - Mill Tailings
- WR - Waste Rock
- SS - Soil (Surface or Depth)
- AS - Asbestos
- UK - Unknown

Location: 1-? Depending on the number of samples necessary for each medium. Sample locations must be carefully described in the field logbook and plotted on the site sketch.

All samples will be labeled in the field and will document the date and time of sample collection, the sample number, any preservatives used, analyses requested, and the sampler's initials. A permanent marker will be used for labeling, and labels will be covered with clear tape and sealed and tagged per EPA procedures.

#### 4.1.3 Sample Preservation and Handling

Samples will be preserved immediately upon sample collection if applicable. Sample preservation, containers, and holding times are listed in Table 1. All procedures strictly follow the appropriate protocols.

All samples will be placed in plastic ziplock bags and stored in coolers. Chain-of-custody records will be kept with the samples and custody seals will be placed on the coolers.



**TABLE 1**  
**SAMPLE COLLECTION, PRESERVATION, AND HOLDING TIMES**  
**ABANDONED MINES HAZARDOUS MATERIALS INVENTORY**

| MEDIA | PARAMETER                                      | REFERENCE   | PRESERVATION  | HOLDING TIME                             | SAMPLE SIZE | BOTTLE      |
|-------|--|---|---|--|-------------|-------------|
| Solid | TAL plus cyanide                               | CLP SOW 3/90  | Ice to 4°C  | 180 days; Hg 26 days; Cyanide 12 days    | 8 oz.       | 8 oz. glass |
| Solid | Sulfur fractions and Neutralization potential* | Modified EPA 600/2-78-054 and EPA-670/2-74-070 OAMS and SWQ | Ice to 4°C  | 30 days                                  | 4 oz.       | 4 oz.       |
| Solid | SMP Buffer*                                    | 12-3.4.4.1 MSA  | Ice to 4°C  | 30 days                                  | 4 oz.       | 4oz.        |
| Solid | Exchangeable Acidity*                          | 9-4.1 MSA   | Ice to 4°C  | 30 days                                  | 4 oz.       | 4oz.        |
| Solid | Asbestos                                       | 40 CFR Ch.1   | None  | None                                     | 4 oz.       | ziplock     |
| Solid | Particle size                                  | Method D421 ASTM  | None  | None                                     | 4 oz.       | 4 oz.       |
| Solid | Cation exchange capacity                       | Method 9081 SW-846  | None  | 7 days until drying; 8 mos. after drying | 4 oz.       | 4 oz.       |
| Water | TAL metals                                     | CLP SOW 3/90  | HNO <sub>3</sub> to pH <2                           | 180 days; Hg 26 days                     | 1 L         | 1 L Poly    |
| Water | Cyanide  | CLP SOW 3/90  | NaOH to pH>12; Ice to 4°C                           | 12 days                                  |             |             |
| Water | Sulfate**                                      | Method 9038 SW-846 or 375.1 CAWW                            | Ice to 4°C  | 28 days                                  | 1 L         | 1 L Poly    |
| Water | Nitrate/Nitrite                                | Method 353.2 CAWW   | H <sub>2</sub> SO <sub>4</sub> to pH <2; Ice to 4°C | 28 days                                  | 250 ml      | 250 ml Poly |
| Water | Chloride**                                     | Method 325.1 or 325.3 CAWW                                  | Ice to 4°C  | 28 days                                  | 1 L         | 1 L Poly    |
| Water | Hardness**                                     | Method 130.2 CAWW   | Ice to 4°C  | 28 days                                  | 1 L         | 1 L Poly    |
| Water | TDS**  | Method 160.1 CAWW   | Ice to 4°C  | 7 days                                   | 500 ml      | 1 L Poly    |

- \* - Sulfur fractions, Neutralization potential, Exchangeable acidity, and SMP buffer are used to determine lime requirement and can be analyzed from the same 4 oz. bottle.
- \*\* - Chloride, Sulfate, Hardness and TDS can be analyzed from the same 1 L Poly.
- TAL - Target Analyte List; from the EPA Contract Lab Program (CLP) SOW (EPA, 1990); only some of these analytes will be analyzed, selected on a case-by-case basis.
- CAWW - Methods for Chemical Analysis of Water and Wastes (EPA, 1984).
- SW-846 - Test Methods for Evaluating Solid Waste-Physical/Chemical Methods, SW-846 (EPA, 1986).
- OAMS - Field and Laboratory Methods Applicable to Overburden and Minesoils (EPA, 1978).
- SWQ - Mine Spoils Potentials for Soil and Water Quality (EPA, 1974).
- MSA - Methods of Soil Analysis Part 2: Chemical and Microbiological Properties (SSSA, 1982).
- ASTM - American Society for Testing and Materials (ASTM, 1985).



#### 4.1.4 Documentation

All field sampling activities and non-sampling data collection will be recorded on the inventory form for the site. The field team leader is responsible for recording information including weather conditions, field crew members, visitors to the site, samples collected, the date and time of sample collection, procedures used, any field data collected, and any deviations from this SAP, per EPA guidance.

#### 4.1.5 Post-sampling Activities

All personnel must go through decontamination procedures when leaving a contaminated area for their own protection. Personnel decontamination includes routine practices as well as emergency decontamination; all procedures follow EPA protocols. All measures will be taken to prevent the spread of potentially hazardous materials to clean areas.

All potentially contaminated fluids, sampling equipment, and personal protective materials generated on-site will be containerized and disposed of properly. All wastes will be managed according to Office of Emergency and Remedial Response (OERR) Directive 9345.3-02 "Management of Investigation Derived Wastes During Site Inspections" (EPA, 1991).

All samples will be either hand-delivered or shipped via Federal Express to the laboratories under strict EPA chain-of-custody. Samples will be shipped in coolers, which will be kept cool with ice and insulated with appropriate packing material; this will prevent detrimental effects from possible sample container leakage. Custody seals will protect the integrity of the samples while in transit to the laboratory.

#### 4.2 QA/QC SAMPLING

QA/QC samples to be collected will include: duplicates of groundwater samples at 1:20, and water blank samples at 1:20. The duplicate sample will be generated by collecting two samples from one groundwater sampling location. The duplicate sample checks the reproducibility of sampling data. The equipment rinsate samples will not be collected due to the use of precleaned disposable equipment or direct submersion of sample bottles. The water blank sample is generated by pouring purified (ASTM Type II, metals free) water directly into the sample containers. The water blank sample checks the quality of the laboratory data and cleanliness of the sample containers. The QA/QC samples will be analyzed for the same constituents as the field samples.

## 5.0 PROJECT MANAGEMENT/PERSONNEL

Personnel and their associated responsibility with the Abandoned Mines Hazardous Materials Inventory are listed below.

1) MDSL Project Officer - Mr. Earl McCurley/AMRB

Oversight of the entire project, including: planning and support, document review and approval; project administration; and, community relations.

2) Field Project Officer/Field Team Leader/Health and Safety Officer - Mr. Bill Bullock/Pioneer

Responsible for overall management of the inventory and implementation of supporting documents. Assists in field activities and documents activities on the inventory form. Responsible for equipment, problem solving, and decision making in the field. Ensures that work crews comply with all site health and safety requirements and will revise the Health and Safety Plan (Pioneer, 1993c) if necessary.

3) Field Team Leader/Health and Safety Officer/Quality Assurance Manager - Ms. Meg Babits/Pioneer

Assists in field activities and documents activities on the inventory form. Responsible for equipment, problem solving, and decision making in the field. Ensures that work crews comply with all site health and safety requirements and will revise the Health and Safety Plan (Pioneer, 1993c) if necessary. The Quality Assurance Manager will be the leader of the data review, data validation, and auditing requirements.

4) Field Team Leader/Health and Safety Officer - Mr. Dave Tuesday/Pioneer

Assists in field activities and documents activities on the inventory form. Responsible for equipment, problem solving, and decision making in the field. Ensures that work crews comply with all site health and safety requirements and will revise the Health and Safety Plan (Pioneer, 1993c) if necessary.

5) Field Team Samplers - Julie Flammang and Jodi Belanger, Pioneer; and Taylor Pierson, TD&H.

Responsible for implementation of the sampling procedures, sample custody, field equipment operation, maintenance, calibration, and standardization.

6) XRF Operators - Dawn Clark and Mike Lasher, Pioneer

Responsible for XRF sample preparation, operating the field XRFs, logging and reducing data, and assisting in laboratory sample preparation and paperwork. XRF operators will also assist in sampling activities when XRF analysis requirements are low.

## 6.0 SCHEDULE

The Abandoned Mines Hazardous Materials Inventory field activities will begin on May 19, 1993 and proceed to completion; approximately 20 weeks. The logistics includes two field sampling teams of three persons each. Each field team will have a field team leader, a field team member, and an XRF operator. The field team leaders will rotate among three Pioneer principals allowing one principal to remain in the office to coordinate data as needed. Each field sampling team will perform at separate sites that may not be in close proximity.

## 7.0 REFERENCES

Montana Abandoned Mine Reclamation Bureau, October 1990, Procedures Manual, MDSL/AMRB, Helena, Montana.

Montana Abandoned Mine Reclamation Bureau, December 1990, Standard Construction Specifications for Abandoned Mine Reclamation, MDSL/AMRB, Helena, Montana.

Pioneer, 1993a. Final Quality Assurance Project Plan for the Abandoned Mines Hazardous Materials Inventory. June 1993.

Pioneer, 1993b. Final Laboratory Analytical Protocol for the Abandoned Mines Hazardous Materials Inventory. June 1993.

Pioneer, 1993c. Final Health and Safety Plan for the Abandoned Mines Hazardous Materials Inventory. May 1993.

Staff, U.S. Bureau of Mines, March 1, 1993 Abandoned Mine Land Inventory and Hazard Evaluation Handbook.

U.S. Environmental Protection Agency, 1991. Management of Investigation Derived Wastes During Site Investigations.

**APPENDIX A**  
**AMRB HAZARDOUS MATERIALS INVENTORY FORM**  
**INSTRUCTIONS**





**NOTE TO THE USER:**

The following instructions are intended to provide the User with general guidance on the information required for each line on the form. In order to complete this form correctly, the user must also carefully review the Sampling and Analysis Plan and Standard Operating Procedures for the Abandoned Mines Hazardous Materials Inventory.



# **ACRONYMS AND ABBREVIATIONS LIST FOR THE ABANDONED MINES HAZARDOUS MATERIALS INVENTORY**

|                 |   |
|-----------------|---|
| ACM             | Asbestos Containing Materials   |
| AD              | Adits with water discharge  |
| ALK.            | Alkalinity expressed in mg/L as CaCO <sub>3</sub>                           |
| AMD             | Acid Mine Drainage  |
| AMRB            | Abandoned Mine Reclamation Bureau of the Montana Department of State Lands. |
| BAR             | Barrels   |
| CFS             | Cubic Feet per Second   |
| CLP             | Contract Laboratory Program   |
| CN <sup>-</sup> | Cyanide   |
| D               | Direct  |
| DMP             | Refuge Dump   |
| E               | Estimated   |
| ESD             | Evaporative Salt Deposits   |
| ft              | feet  |
| FEOX            | Ferric Hydroxide Precipitates   |
| Hg              | Mercury   |
| HMO             | Hazardous Mine Openings   |
| I.D.            | Identification  |
| M               | Measured  |
| MBMG            | Montana Bureau of Mines and Geology   |
| mg/L            | Milligrams per Liter  |
| MW              | Monitoring Wells  |
| mR/HR           | MilliRoentgens per hour   |
| mV              | Millivolts  |
| No.             | Number  |
| OTH             | Other Waste Source  |
| R               | Range   |
| RW              | Residential Wells   |
| S               | Saturated Paste   |
| SAMP.           | Sample  |
| SC              | Specific Conductance  |
| Sec.            | Section   |
| SH              | Shafts filled with water  |
| SOP             | Standard Operating Procedure  |
| SP              | Spills or Leaks   |
| SPG             | Discolored or Turbid Seepage  |
| SU              | Standard Units  |
| T               | Township  |
| T&E             | Threatened and Endangered Species   |
| TAIL            | Mill Tailings   |
| USGS            | United States Geological Survey   |
| VAT             | Vats, Vessels or Tanks  |
| VEG             | Presence of Burned or Stressed Vegetation                                   |
| WR              | Waste Rock  |
| XRF             | X-Ray Fluorescence Spectrophotometer  |
| yr              | Year  |
| μS/cm           | Micromhos per centimeter  |
| °C              | Degrees Celsius   |
| 4wd             | Four wheel drive vehicle  |
| 1/4             | Quarter section   |
| #               | Number  |





MONTANA DEPARTMENT OF STATE LANDS  
ABANDONED MINE RECLAMATION BUREAU

HAZARDOUS MATERIALS INVENTORY  
SITE INVESTIGATION LOG SHEET

Mine/Site Name: (as on AMRB Inventory field form) PA#: (Prob. Area No.)

Date: (of investigation) Time: (arrival/departure)

Field Team Leader: (Name and Company)

Sampling Personnel: (Name and Company)

Visitors: (Name and Affiliation)

Weather/Seasonality Observations: (Temperature, approximate wind speed and direction, cloud cover, as well as seasonality considerations such as spring melt, mid summer dry period, whether recent rainfall has occurred.)

Photographic Log (Film Roll and Photo No.'s/Video Tape Number): (Color slide film roll No. and Exposure Nos. as well as Video tape No. - Photograph sample locations, openings, waste sources and exposure pathways. Note photo No. corresponding to each.)

General Comments/Observations (not covered specifically in attached Inventory Forms):  
(Provide comments on the site characteristics and sampling activities that are not specifically covered in the Inventory form.)

**Other Hazardous Materials/Substances Observed:** *(Note presence of milling reagents, petroleum products, transformer oil, asbestos, etc.)*

**General Comments on Potential Remediation Alternatives:** *(Note obvious potential remedial alternatives based on site-specific conditions/factors.)*

## I. BACKGROUND INFORMATION

This information is to be collected to the extent practical prior to conducting the site investigation. Data gaps shall be filled in during the investigation.

Mine/Site Name(s): (as on the AMRB Invent.) PA#: (Problem Area No.)

Legal Description: T       ; R       ; Section       , 1/4 1/4 1/4.  
(Township, Range, quarter sections and Section.)

County: (Name) Mining District: (Name)  
(or local name of unorganized district and noted as such)

Latitude:                      Longitude:                       
(Degrees, minutes, seconds)

Primary Drainage Basin and Code:                                       
(Smallest named stream on the USGS Hydrologic Unit Map and USGS 8-digit code)

Secondary Drainage Basin:                                       
(Smallest named stream on USGS Quadrangle Map)

USGS Quadrangle map name(s): (Name of map the site is located on.)

Mine Type/Commodities: (Note whether the site is hardrock, placer or industrial mineral and the mineral(s) extracted.)

Activity Status: Active        Inactive/Exploration        Abandoned       .

Ownership status: Known Y        N       ; private/public?                     

Owner (include address and phone when available):                                       
(Most current owner known)

Relationship to other mines/sites in the area/district:                                       
(Note mines that are connected by underground workings or that share the same ore body. Also note mines of similar ownership in the area.)

Regulatory Status (Activity by other agencies)? Hardrock permits?                       
Past Reclamation Activities? (Note AMRB reclamation activities or investigations conducted or in progress by other agencies.)

General site features: Elevation (feet)           , Slope (percent)           ,  
Aspect (direction facing)                     

Land use: Mining       , Recreational       , Residential       , Urban       ,  
Agricultural       , Other (Specify) (Check most appropriate)

Area of disturbed/unvegetated lands?                      acres.

Dimensions (Note the approx. length, width and orientation with regard to significant land features.)

Predominant vegetation types: (Note the dominant tree, shrub, grass, and forb species present.)

Access: roads - good       , poor       , 4wd       , trail       .

Other logistical considerations (proximity to other sites).                       
(Note other sites to be investigated in close proximity)



Well logs within 4 mile radius; water rights 15 mi downstream (Attach  
MRMG Well Log Printout(s), Page 6):

(Self-explanatory)

General site geologic, hydrologic, and hydrogeologic settings (Also  
note presence of radioactive minerals). (Note the geologic formation, surface water setting  
such as presence of perennial and intermittent stream, and the approximate depth  
to groundwater.)

Mining/milling history, ore type/tenor, host rock, gangue:  
(Note any details available from historic records on the history of the site and  
materials mined.)

**Mine Operation?**

Shafts - Yes\_\_\_, No\_\_\_, #\_\_\_, Comment (Water? Accessible?)\_\_\_  
Adits - Yes\_\_\_, No\_\_\_, #\_\_\_, Comment\_\_\_  
Pits - Yes\_\_\_, No\_\_\_, #\_\_\_, Comment\_\_\_  
Placers - Yes\_\_\_, No\_\_\_, #\_\_\_, Comment\_\_\_  
Other - Yes\_\_\_, No\_\_\_, #\_\_\_, Comment\_\_\_

Mill Operation? Yes\_\_\_, No\_\_\_. If yes answer the next three  
questions:

Period(s) of Operation: (Year that mill began and ended operation.)

Origin of Ore Milled - Custom Mill\_\_\_ Dedicated Mill\_\_\_; Number and  
names of mines that supplied mill feed:\_\_\_  
(Ore source will effect the waste product characteristics.)

Process? Hg-amalgam, CN<sup>-</sup> leach (vat, heap), floatation, smelting?  
(Note the process used in order to predict other potential contaminants of  
concern and estimate the efficiency of the milling process.)

### SUMMARY OF EXISTING ANALYTICAL DATA:

Include in tabular form information concerning samples taken including sample designation, location, date (seasonality), media, concentration, and comments on likely data quality and source.

Groundwater, Surface Water, Air, Soil, Waste Rock/Tailings, Other.

[illegible]

**Note: Attach Data sheets when existing data is voluminous.**

**Site Sketch:**

*Prepare base maps to be used for field mapping from the inventory sketches and enlargements of USGS quad sheets. These maps will be used by XRF team and samplers to mark sample locations and enhanced by the Field Team Leader to include the additional required information.*

Topographic areal map: 1:12,000 (2x blowup of 7 1/2 minute quadrangle sheet)



MBMG Well Logs

## II. INFORMATION COLLECTED ON SITE

### A. SOLID MATRIX WASTE CHARACTERIZATION

1. Waste characteristics - Use table on following page.

Unique source identification (e.g. west waste rock dump #2) and abbreviation on sketch map and source list (e.g. WWRD2). Locate source on sketch map with any measured distances from at least two landmarks.

Source types: Waste rock dumps and piles (WR); tailings impoundments and piles (TAIL); vats, vessels, tanks that contain something (VAT); barrels - not empty (BAR); soils contaminated by spills or leaks (SP); suspected asbestos containing materials (ACM); garbage/refuse/junk dumps (DMP); other sources (OTH).

Source size: List measured linear dimensions (x feet by y feet) and approximate depth, or estimated volumes (cu. yards or feet, # of barrels) for each source identified above.

Location/Description: Provide a description of the subsample location, the depth interval of the sample, and a description to the media color and texture.

Waste containment: Is the source contained with respect to groundwater, surface water, and airborne releases or the potential to release? Good, adequate, poor, or none. Are waste structures / vessels sound, are runoff controls in place, are wastes covered or vegetated, pond liners intact?

2. TAILINGS IMPOUNDMENTS - If tailings impoundments are also present, complete the following questions.

Describe the tailings grain size distribution (approximate % sand, silt, & clay): \_\_\_\_\_ (Estimate using soil texturing field methods.)

Determine tailings impoundment depth and describe stratification of the tailings if observable (based on texture and color): (Judge through tailings impoundment when possible to determine the depth of tailings and note the widths of the stratified layers when present.)

Are tailings wet or dry (Describe location of partially wetted tailings impoundments): (Note whether the tailings are saturated or moist and the areal extent of wetted tailings.)

Describe condition of the tailings impoundment (Note condition of dams or structures, location of breaches): (Note the condition of the tailings dam or berm, whether catastrophic failure is possible, if failure has already occurred, etc.)

Comments on potential for mitigation (Note comments on obvious mitigative potential mitigative measures such as runoff/runoff control, repair of containment structures, removal to wastes from floodplains, etc.)



## B. GROUNDWATER CHARACTERISTICS

Use table on following page. Identify all locations on sketch map or topographic map.

Flowing adits: Yes ☐ No ☐ Number: \_\_\_\_\_ Identification: (i.e., AD-01, SH-01)

Filled shafts: Yes ☐ No ☐ Number: \_\_\_\_\_ Identification: \_\_\_\_\_

Residential wells within 4 miles: Yes ☐ No ☐ Number: (BMG Logs) \_\_\_\_\_  
Number actually observed/confirmed: (Field Verify) \_\_\_\_\_

Distance to nearest well used for drinking? (Determine the nearest well used for domestic purposes.) \_\_\_\_\_

Sample types: Flowing adits (AD)? filled shafts (SH)?  
Residential wells (RW)? Monitoring wells (MW)?

Field Measurements: Flow (measured or estimated), pH (meter), Eh (meter), SC (meter), temperature (meter), Alkalinity (test kit)?

Potential for groundwater contamination (explain)?

Definite ☐ Probable ☐ Possible ☐ Unlikely ☐  
(Base observation on field measurements, odors indicating elevated bacterial activity, presence of precipitates, stressed vegetation, lack of aquatic life in the discharge water.)

Other observations/notes: (Note any other significant observations related to the groundwater resources not covered by the standard form.)



**SOURCE INVENTORY FORM**

**SAMPLERS:** (Names of personnel involved in sample collection.)

**SAMPLERS:** (Names of personnel involved in sample collection.)

[illegible]

\*D-Direct reading(Kelway Meter); S-Saturated Paste(Orion Meter)

**Comments or deviations from SOPs(Pioneer SAP, 1993):** (Note any deviations from the SOPs when collecting the samples or measurements, and any other observations not covered in the standard forms.)

SAMPLERS: (Names of personnel involved in sample collection effort.)

**SAMPLERS:** (Names of personnel involved in sample collection effort.)

[illegible]

**FLOW:** Estimated (E) or Measured (M) from the adit, shaft, seep or spring?

**Comments or Deviations from the SOPs:**

## C. SURFACE WATER CHARACTERISTICS

Use table on following page. Identify all locations on sketch map or topographic map. Indicate drainage patterns (run-on/runoff) and directions on sketch maps.

Flowing streams: Yes\_\_\_\_, No\_\_\_\_, Name(s):\_\_\_\_ (Note whether stream is perennial or a flowing intermittent stream if possible. If drainage is unnamed, describe its location and plot it on the sketch map.)

Dry streambeds: Yes\_\_\_\_, No\_\_\_\_, Name(s):\_\_\_\_ (Describe and plot intermittent drainages potentially impacted by the site.)

Other surface water: Yes\_\_\_\_, No\_\_\_\_, Name(s)/Description:\_\_\_\_ (Describe and plot ponds or wetlands potentially impacted by the site.)

Waste materials within any floodplain: Yes\_\_\_\_, No\_\_\_\_, Source ID(s):\_\_\_\_ (Note sources in the floodplain and estimated flow frequency.)

Approximate Flood frequency?\_\_\_\_1 yr,\_\_\_\_10 yr,\_\_\_\_100 yr

Estimated seasonal flow of stream(s) (cfs)? (Use gauging station data, measurements of highwater marks or USGS Open-File Report 81-917, Revised Techniques for Estimating Magnitude and Frequency of Floods in Montana for each ungaged drainage.

High Flow:\_\_\_\_\_

Average Flow:\_\_\_\_\_

Distance between wastes and nearest surface water body (ft)?\_\_\_\_ (Note the distance between waste sources and the nearest surface water if not already addressed by the questions above.)

Surface water draining onto or through wastes: Yes\_\_\_\_, No\_\_\_\_, Describe:\_\_\_\_ (Note any surface water flows in direct contact with the waste sources. Also note if non-flowing intermittent runoff paths are present through waste sources.

Surface water use within 15 miles downstream? (Drinking water supply, irrigation, residential use? Sensitive environments within 15 miles downstream? Park, Wilderness, Fishery, Wetland, T&E habitat?)  
\_\_\_\_ (Determined by visual observation en-route to the site or based on information available on maps.)

Observed erosional / sedimentation / stream turbidity problems?\_\_\_\_  
Distance downstream (ft)?\_\_\_\_ Describe/explain (Note streambank stability and condition of streambank vegetation and any manmade structures or channel changes present):\_\_\_\_  
\_\_\_\_ (Self-explanatory)



**SAMPLERS:** (Names of personnel involved in the sampling effort.)

SAMPLERS: (Names of personnel involved in the sampling effort.)

[illegible]

Comments or Deviations from the SOPs (Pioneer SAP, 1993):



## D. ACID MINE DRAINAGE (AMD) POTENTIAL

Evaluate each source in table on next page.

### AMD Characteristics:

Presence and abundance of sulfides? (SO<sub>3</sub>)

Presence of evaporative salt deposits? (ESD)

Discolored or turbid seepage? (SPG)

Presence of long filamentous algae in drainages, mosses in moist areas?

Presence of ferric hydroxide precipitates? (FEOX)

Presence of burned or stressed vegetation? (VEG)

### General Potential for AMD Mitigation:

Area available for treatment (acres)? (Note area available for manmade wetlands, treatment/settling ponds, or anoxic limestone drains.)

Wetlands present: Yes     , No     , Describe: (Note the presence and extent of the wetlands present and any indication of the natural treatment of water presently occurring by changes in field parameters, sediment loads or color.)

Carbonate rocks/soils: Yes     , No     , Describe: (Note the presence of any carbonate-based rock formations or soil types in the vicinity of the site which may aid in buffering the acid mine drainage or be used in a treatment measure.)

## E. AIR PATHWAY CHARACTERISTICS

Population within 4-mile radius? (From the USGS Quad. Sheet and observed.)

Nearest residence (ft or miles)? (As observed during the Site Investigation.)

For each source (table next page):

Available fine materials?      Surface area?

Uncovered and unvegetated?      Wet or dry?

Overall dust propagation potential:  
            observed      high      moderate      low      none

# **ACID DRAINAGE/AIR PATHWAY INVENTORY FORM**

**SAMPLERS:** Names of personnel involved in the measurement/observation.

| SOURCE<br>I.D.<br>NO. | ACID MINE DRAINAGE<br>CHARACTERISTICS<br>(LIST) | MOISTURE<br>CONTENT<br>(WET/DRY/PARTIAL) | SURFACE<br>AREA<br>(SQUARE FEET) | UNCOVERED/UNVEGETATED<br>AREA<br>(PERCENT) | AVAILABLE<br>FINES<br>(YES/NO) | DUST PROPAGATION<br>POTENTIAL (OBSERVED/HIGH<br>/MODERATE/LOW/NONE) |
|-----------------------|---|--|----------------------------------|--|--------------------------------|---|
| See<br>above          | See above                                       | See above                                | See above                        | See above                                  | See above                      | See above   |
|                       |   |  |                                  |  |                                |   |
|                       |   |  |                                  |  |                                |   |
|                       |   |  |                                  |  |                                |   |
|                       |   |  |                                  |  |                                |   |
|                       |   |  |                                  |  |                                |   |
|                       |   |  |                                  |  |                                |   |
|                       |   |  |                                  |  |                                |   |
|                       |   |  |                                  |  |                                |   |
|                       |   |  |                                  |  |                                |   |
|                       |   |  |                                  |  |                                |   |
|                       |   |  |                                  |  |                                |   |
|                       |   |  |                                  |  |                                |   |
|                       |   |  |                                  |  |                                |   |
|                       |   |  |                                  |  |                                |   |

**Notes and Clarifications:** (Note any observations not covered by the standard forms.)

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## F. DIRECT CONTACT CHARACTERISTICS

Residents or workers within 200 feet of sources: Yes\_\_\_\_, No\_\_\_\_,  
Describe: (Observed)

Population within 1 mile? (Observed during the Site Investigation.)

Evidence of recreational use on site: Yes\_\_\_\_, No\_\_\_\_, Describe: (Note tracks of off-road vehicles, presence or evidence of fisherman/hunters, hikers, etc.)

Accessibility - Fences, warning signs, closed roads? (Note presence and condition of fence or presence of other barriers to prohibit access.)

Observed surface (0-2 ft) soil contamination? (XRF readings.)

Areal extent(acres)? (XRF readings)

### Sensitive environments on-site:

|                           |   |
|---------------------------|---|
| State or National Parks - | Yes____, No____, Comment <u>(As observed)</u> |
| Wilderness Area -         | Yes____, No____, Comment _____                |
| Class I Fishery -         | Yes____, No____, Comment _____                |
| Riparian Zones -          | Yes____, No____, Comment _____                |
| Wetlands -                | Yes____, No____, Comment _____                |
| T&E Species Habitat -     | Yes____, No____, Comment _____                |
| Bat Habitat -             | Yes____, No____, Comment _____                |

## G. SAFETY CHARACTERISTICS

Verify completeness of AMRB Inventory

Hazardous openings: Yes\_\_\_\_, No\_\_\_\_, Number\_\_\_\_, types and locations:\_\_\_\_  
(Adit, shaft, raise, stope, subsidence)

Hazardous structures: Yes\_\_\_\_, No\_\_\_\_, Number\_\_\_\_, types and locations:\_\_\_\_  
(Buildings or related equipment that has become a safety hazard.)

Unstable highwalls, pits, trenches, slopes: Yes\_\_\_\_, No\_\_\_\_, Number\_\_\_\_, types and locations:\_\_\_\_  
(Self-explanatory)

Unstable waste piles, impoundments, undercut banks: Yes\_\_\_\_, No\_\_\_\_, Number\_\_\_\_, types and locations:\_\_\_\_  
(Self-explanatory)

Fire and/or Explosion hazards: Yes\_\_\_\_, No\_\_\_\_, Explain:\_\_\_\_  
(Self-explanatory)

**APPENDIX B**

**STANDARD OPERATING PROCEDURES**

**FOR THE**

**ABANDONED MINES HAZARDOUS MATERIALS INVENTORY**





**STANDARD OPERATING PROCEDURE  
PERSONNEL DECONTAMINATION PROCEDURES**

All personnel must go through decontamination procedures whenever leaving a contaminated area. Decontamination procedures should be used in conjunction with methods to prevent contamination including minimizing contact with wastes and maximizing worker protection.

**PROTECTION:**

1. Follow personal protective measures in the Site Safety Plan.
2. In the event that personnel decontamination becomes necessary, the outer more heavily contaminated items should be soap (nonphosphate)/tap water washed. Rinse the items in tap water.
3. Next, the inner, less contaminated items should be soap (nonphosphate)/tap water washed. Rinse the items in tap water.
4. Store the items separately so they are used in contaminated areas only.
5. For contaminants other than those found typically at uncontrolled hazardous waste sites, see the Health and Safety Manager.

**EMERGENCY DECONTAMINATION:**

1. If the decontamination procedure is essential to the life-saving process, decontamination must be performed immediately.
2. If heat related illness develops, protective clothing should be removed as soon as possible.

**WASH, RINSE AND/OR CUT OFF PROTECTIVE CLOTHING/EQUIPMENT**

3. If medical treatment is required to save a life, decontamination should be delayed until the victim is stabilized. Wrap the victim to reduce contamination of others.
4. Alert medical personnel to the emergency and instruct them about potential contamination. Instruct medical personnel about specific decontamination procedures.
5. Dispose contaminated clothing and equipment properly.

**STANDARD OPERATING PROCEDURE  
EQUIPMENT DECONTAMINATION**

All equipment leaving the contaminated area of a site must be decontaminated. Decontamination methods include physical removal, chemical removal and a combination of both. Decontamination procedures, in some cases, are to be performed in the same level of protection used in the contaminated area of a site. However, decontamination personnel may be sufficiently protected by wearing one level lower protection. The following decontamination procedures are for typical uncontrolled hazardous waste sites. For a more specific or unusual contaminant such as dioxins, see the Site Health and Safety Plan. Decontamination procedures should be used in conjunction with methods to prevent contamination of sampling and monitoring equipment.

**INORGANIC CONTAMINANTS - HEAVY METALS:**

1. Remove gross contamination with a water rinse using pressurized or gravity flow tap water.
2. Wash equipment in a solution of soap (nonphosphate) and tap water with a stiff brush.
3. Triple rinse the equipment with distilled water.
4. Rinse the equipment with a mixture of 10:1 Nitric acid in distilled water (10 parts water to 1 part Nitric acid).
5. Rinse the equipment again with distilled water.

**ORGANIC CONTAMINANTS:**

1. Remove gross contamination physically with a disposable paper towel or with a water rinse using pressurized or gravity flow.
2. Wash equipment in a solution of soap (nonphosphate) and tap water with a stiff brush.
3. Triple rinse the equipment in tap water.
4. Triple rinse the equipment with deionized water.
5. Triple rinse the equipment with methanol. If testing for dioxins, a hexane triple rinse will be included as part of the decontamination.

PTS-SOP-SA-01

STANDARD OPERATING PROCEDURE  
SOIL AND WATER SAMPLE PACKAGING AND SHIPPING

1. WATER SAMPLE PRESERVATION precedes if the sample to be packed is water and preservation is required.
2. Each of the filled sample containers will be placed in separate ziplock bags to keep it clean, dry, isolated, and to protect the sample label. Samples will then be placed in a cooler which has been lined with a plastic bag. The samples will be surrounded with vermiculite to reduce movement and absorb any leakage. The garbage bag will then be tied to contain the vermiculite.
3. The Field Team Leader will double check the paper work (COC, etc.) to assure those samples recorded on the associated paper work are in the cooler. The Field Team Leader and the sampler will then sign the chain-of-custody form to relinquish custody.
4. The paper work will then be placed in a sealed ziplock bag and taped to the inside of the cooler lid.
5. The cooler will be labeled with the appropriate shipping labels (NOS, flammable liquids, flammable solids, this side up, fragile, etc.).
6. The cooler will then be closed and an address label will be affixed to the lid (a Federal Express label will also be affixed, if used, at this time).
7. The cooler will then be closed and chain-of-custody seals will be placed over the opening.
8. Tape will then be placed over the custody seals and around the cooler.
9. The cooler(s) will then be transported to a secure storage, to the shipping agent, or directly to the laboratory.

Note:       Bagging of samples and lining of coolers will not be necessary if samplers transport samples directly to the laboratory.



#### EQUIPMENT USED FOR DECONTAMINATION:

1. Triple rinse equipment (brushes, buckets, tubs) used in the decontamination process with water, preferably pressurized.
2. Agitate the equipment used in the decontamination process in the soap/tap water solution. (The tub which holds the solution will only have the water rinse.)
3. Triple rinse equipment with tap water.
4. Place equipment in appropriate areas, so they are used only for decontamination purposes (label if necessary).

#### DISPOSAL OF DECONTAMINATION SOLUTIONS:

1. Proper disposal of the soap/tap water solution, the tap water rinse, and the deionized water rinse is to a proper waste water container.
2. Proper disposal of the solvent rinse is to a proper organic solvent waste container.
3. When contaminants have been identified, either in the solutions or elsewhere on the site, solutions should be disposed of appropriately. If they are hazardous (characteristic, listed, etc.) dispose of them as such.
5. WHEN USING OTHER THAN THE ABOVE MENTIONED SOLUTIONS, BE SURE TO CHECK WITH THE HEALTH AND SAFETY OFFICER AND THE PROJECT MANAGER. SOME SOLVENTS MUST BE EVAPORATED.

#### EFFECTIVENESS OF DECONTAMINATION:

1. Effectiveness of the decontamination procedures will be measured using field equipment rinsate blanks (see the PROJECT QAjPP).

PTS-SOP-FM-01

STANDARD OPERATING PROCEDURE  
FIELD MEASUREMENT OF pH & Eh IN WATER

Field Procedures

1. Rinse beaker with sample water three times.
2. Rinse pH and temperature probes with deionized water.
3. Fill beaker with sample water.
4. Turn on meter and immerse pH probe and temperature electrodes in sample water. Stir sample for thorough mixing. Read and record pH to nearest 0.01 unit once pH reading has stabilized.
5. Rinse electrodes with deionized water and store in carrying case.

Note: pH may also be measured by placing the probe directly into the water body being tested. The probe must be moved slowly in a circular motion when measuring stagnate waters.

Instrument Calibration

Calibrate pH meter in the field at the beginning of each day of field work and when the standard check is out of calibration. Recheck calibration at end of day.

1. Rinse pH and temperature probes in deionized water.
2. Turn on meter and immerse pH and temperature probe in a pH 7 buffer solution. Calibrate meter to pH 7 allowing enough time for meter to stabilize.
3. Rinse pH and temperature probe with deionized water.
4. Immerse pH and temperature probe in either a pH 4 or a pH 10 buffer solution depending on whether expected pH of samples is above or below pH 7. If expected sample pH is above pH 7, use pH 10 solution for the second calibration. If expected sample pH is below pH 7, use pH 4 for the second calibration. Calibrate meter to second pH solution allowing enough time for meter to stabilize.
5. Rinse pH and temperature probe with deionized water.
6. Recheck meter calibration to a pH 7 calibration solution. Repeat the calibration process (Steps 2-4) if value for final pH check is more than 0.1 units from pH 7.0.

### Redox-Potential (EH) Measurements

EH measurements are performed using ORION model 96-78 redox electrode and ORION SA-210 or 250A portable meter set to the millivolt (mV) mode.

#### Filling Electrode:

The electrode shall be filled with one of the two solutions selected to best match the ionic strength of the sample solution to minimize junction potentials. The following solutions shall be used:

1. Dilute solution [total ionic strength less than 0.2 molar (M)]. Use ORION dilute filling solution (Cat. No. 900001), which will match the potential of a conventional calomel electrode.
2. Concentrated solution (total ionic strength greater than 0.2M). Use ORION concentrated filling solution (Cat. No. 900011), which is 4M KCl saturated with Ag/AgCl.

Filling solution level in the electrode should always be at least one inch above the level of the solution being measured.

#### Connecting the Electrode to the Meter:

Insert the platinum redox connector (large diameter) in the pH or sensing electrode input jack on the ORION SA-210 meter and the reference electrode connector (small diameter) into the reference electrode input jack.

#### Calibration Procedure:

The meter shall be calibrated daily using a two stage process that checks the operation and accuracy of the meter. To check the operation of the meter:

1. Connect the electrodes to the meter, place the electrodes in a beaker of tap water, and turn on the meter.
2. Add a drop of dilute NaOH to the beaker and mix it with tap water.
3. If the reading on the meter decreases sharply, then the electrodes are sensitive and operating properly.
4. If little or no change in the reading is observed, then the electrodes are not functioning properly and must be cleaned. The following summarizes the electrode cleaning procedures:
  - Drain filling solution from outer portion of electrode body and refill with fresh solution (see Filling Electrode).

- If the electrode still does not function properly, remove sleeve from the inner electrode, rinse all the parts of the electrode with DS/DI water, and allow to air dry.
- Reassemble electrode and refill with filling solution.

To check the accuracy of the meter and EM electrode:

5. Use a standard solution consisting of Zobell's ferrous/ferric solution.
6. Rinse electrodes with DS/DI water.
7. Pour the standard solution into a small beaker and place electrodes into the beaker. The redox potential of the standard solution should read 439 +/- 30 mV. If the reading deviates from this range, then the electrodes must be cleaned (see Step 4).

#### Measurement Procedure

1. Set the mode switch to the mV position, and place the electrode in the sample solution. When the reading stabilizes, record the potential.
2. For some applications, redox-potential readings are reported relative to the normal hydrogen electrode (NHE). To do this, select the electrode potential (C) value in Table FM-01-1 that corresponds to the filling solution used and the temperature of the solution measured. Substitute the table value for C in the following equation and solve for E.

$E = E_o + C$  where:

E - Oxidation reduction potential of the sample relative to the NHE.

$E_o$  - Potential developed by the platinum redox electrode.

C - Potential developed by the reference electrode relative to the NHE (see Table FM-01-1).



TABLE FM-01-1

POTENTIALS ("C") DEVELOPED BY THE REFERENCE ELECTRODE  
PORTION RELATIVE TO THE NORMAL ELECTRODE AT VARIOUS TEMPERATURES

| <u>Temperature °C</u> | <u>"C" electrode Potential in mV</u> |                        |
|-----------------------|--------------------------------------|------------------------|
|                       | <u>900001 Solution</u>               | <u>900011 Solution</u> |
| 10                    | 251                                  | 214                    |
| 20                    | 244                                  | 204                    |
| 25                    | 241                                  | 199                    |
| 30                    | 238                                  | 194                    |

PTS-SOP-FM-02

STANDARD OPERATING PROCEDURE  
FIELD MEASUREMENT OF pH IN SOIL

Materials Required

1. Orion pH meter [refer to Standard Operating Procedure PTS-SOP-FM-01 for calibration and operating procedures]
2. pH probes and pH-4, pH-7, and pH-10 buffer solutions
3. Hard plastic spoons (teaspoon size, two minimum)
4. Glass stirring rods (two minimum)
5. 50-milliliter (ml) sample beaker (or disposable cup) with lid. Quantity depends on number of samples
6. Deionized (DI) water (two liters minimum)
7. 0.01 M  $\text{CaCl}_2$  (1.47 grams  $\text{CaCl}_2$  x 2  $\text{H}_2\text{O}$ /liter = 2 liters minimum)
8. Paper towels

Field Laboratory Procedures

1. Place approximately 1 teaspoon (about 10 grams) of soil sample in sample beaker.
2. Add about 20 ml of 0.01 M  $\text{CaCl}_2$  into beaker.
3. Stir with glass rod to make slurry. (Clean glass rod with DI water prior to preparing another soil sample.)
4. Attach lid to beaker and shake vigorously.
5. Let beaker stand until sediment has settled. (This will take about 5 minutes for sandy samples to 30 minutes for clayey samples.)
6. Calibrate pH meter according to procedures outlined in SOP-FM-01.
7. Immerse clean pH probe in the supernatant. Gently move the probe up and down without disturbing the sediment.
8. Record pH value of solution in the field log book when stabilized.
9. Decontaminated pH probe and continue on to next sample.

PTS-SOP-FM-03

STANDARD OPERATING PROCEDURE  
FIELD MEASUREMENT OF SPECIFIC CONDUCTANCE

Field Procedures

1. Calibrate instrument as described in instruction manual. Usually the lowest standard is appropriate. Recalibrate at end of day and note any drift. Replace batteries and try fresh standard solutions if meter does not calibrate properly.
2. Rinse decontaminated glass beaker with sample water three times.
3. Fill glass beaker with water sample.
4. Rinse conductivity probe with deionized water and place probe in sample water.
5. Submerge conductivity probe in sample so that flow cell holes are immersed. Turn instrument on to appropriate scale for sample analysis. Read specific conductance and record to the nearest one micromhos/centimeter. Measure sample temperature to the nearest 0.1°C from conductivity meter after temperature has equilibrated.
6. Remove probe from sample and rinse with deionized water.
7. Correct conductivity reading to specific conductance (corrected to 25°C) by multiplying the conductivity value by the temperature correction factor and then by the probe correction factor (unless unit has an automatic temperature correction).

Maintenance

1. Store meter in case during transport. Immerse probe in deionized water for storage.
2. Check batteries before taking meter into the field. Carry spare batteries and deionized water for rinsing probe.
3. Inspect probe for damage or dirt.
4. If meter readings are erratic, return meter and probe to factory for repair.

PTS-SOP-FM-04

STANDARD OPERATING PROCEDURE  
FIELD MEASUREMENT OF WATER TEMPERATURE

NOTE: Often, temperature is measured with a pH meter or the Specific conductance meter. If included as part of those instruments, use SOP for that instrument. Otherwise:

1. Provide two calibrated thermometers inside protective cases for field measurements.
2. Check thermometer for cracks or gaps in the mercury. If cracks or gaps are visible, thermometer will not be used.
3. When possible, measure temperature of surface water at midstream, submersing the thermometer for approximately one minute or until temperature stabilizes.
4. When in situ temperature measurements are not possible, draw sample of at least 200 milliliters into a decontaminated beaker or sample bottle as soon after sampling as possible.
5. Place thermometer in sample. Do not allow thermometer bulb to touch sides of beaker. Allow to equilibrate (about one minute).
6. Record temperature to nearest 0.5°C in field log book or on field data sheet.
7. On a quarterly basis, check field thermometers against NBS-calibrated laboratory thermometer. Agreement should be within 0.5°C.



STANDARD OPERATING PROCEDURE  
STREAMFLOW MEASUREMENT WITH PORTABLE METER

1. Assemble the equipment as per the manufacturer's instructions.
2. Select a stream section where flows are mostly parallel to the banks, there are no sharp turns in the flow direction, and the bottom is reasonably smooth. The section can be smoothed by reshaping the edges, removing rocks from the bottom, and removing branches, weeds, or grasses.
3. Set a tag line or cloth tape across the section, perpendicular to the flow. Anchor both ends securely to stakes or other fixed objects.
4. Determine the measurement interval size necessary so that no interval has greater than 10% of the flow. Generally 20 to 25 intervals are adequate depending on the variability and complexity of the stream channel.
5. Turn on the flowmeter and begin measurements at either the left or right bank. The initial point is generally the tape reading at the water line and has no depth or velocity to measure. Measurement points are best set at whole or half-foot intervals.
6. Water depth is determined by reading the calibrations on the wading rod (three marks = 1 foot interval, two marks = 1/2 foot interval, one mark = 1/10 foot interval); read depths while ignoring the "pile-up" effect on the wading rod.
7. Velocity is measured at the 6/10's depth by moving the probe support so that the foot indicator marks align with the proper scale reading (in hundredths of a foot). Care must be taken to keep the meter pointed directly into the flow and to keep the rod in a vertical position. Wait for a sufficient period of time to obtain an average velocity reading.
8. Record station, depth and velocity on the streamflow field data sheet and calculate the approximate stream flow. Attach the data sheet to the inventory form package.

Note: Very small flows (typically not exceeding 50 gpm) may be measured using the bucket and stopwatch or float and stopwatch methods.

STANDARD OPERATING PROCEDURE  
FIELD MEASUREMENT OF ALKALINITY

Alkalinity is determined by titrating a water sample with a standard solution of sulfuric acid. The end point is selected as pH 4.5.

1. Fill a 25 milliliter (mL) buret with 0.01639 Normal (N) or a known normality sulfuric acid solution.
2. Pipet 50 mL of filtered sample into a clean dry 100 mL beaker. The sample volume may be increased for low ionic strength solution or decreased for solutions of high ionic strength.
3. Rinse pH electrode three times with an aliquot of the sample.
4. Insert pH electrode and a clean dry stirring bar into the sample.
5. Place beaker containing sample on the titration assembly and record the pH.
6. Adjust the stirrer speed to slow, titrate immediately to pH 4.5, and record the titrant volume on the field note sheet.

The calculation for total alkalinity (TA) as  $\text{CaCO}_3$  in milligrams per liter is (titrant normality = 0.06139):

$$\text{TA} = 1000 \div \text{mL Sample} \times 0.8202 \times \text{mL titrate}$$

Caution

If the volume of titrant used in determination exceeds 25 mL (size of buret from step 1), DO NOT refill buret and continue the titration. Select a smaller sample and repeat the procedure from Step 3.

Note: The appropriate Hach reagents may be used instead of the pH meter for colorometric determination of pH endpoints.

PTS-SOP-FM-07

STANDARD OPERATING PROCEDURE  
XRF ANALYSIS

The chemical characterization of solid samples (soil, tailings, waste rock, etc.) in the field will be determined by the field portable X-ray fluorescence (XRF) spectrometer 9000 instrument manufactured by Spectrace Instruments, Inc., Fort Collins, Colorado. The XRF will be used in a prepared application meaning the solid sample will be sieved or ground to minimize void space and the sample will be cupped for measurement on the instrument probe. This is opposed to an in-situ application where the solid sample has no preparation and the reading is on the ground surface.

Objectives

1. To screen on-site solids for selecting biased (high concentration) sample locations for laboratory analysis; and,
2. To characterize (obtain numerous data points) on-site solids.

Source

The instrument has a mercuric iodide (HgI<sub>2</sub>) conductor and three shielded radioactive sources (Fe-55, Cd-109, and Am-241) that produce spectral peaks. The manufacturer states that no personal dosimetry is required for the radioactive source because of the high quality aluminum shielding. The position (energy level) of the spectral peaks is specific to an individual element and the peak height is indicative of the concentration of that element within the area exposed to the source. The sources will allow determination of the following compounds:

| <u>Source</u> | <u>Element Range</u> |
|---------------|----------------------|
| Fe-55         | S to Cr              |
|               | Mo to Ba             |
| Cd-109        | Ca to Rh             |
|               | Ta to Pb             |
|               | Ba to U              |
| Am-241        | Cu to Tm             |
|               | W to U               |

Detection Limit

The detection limit is a function of source strength, particle size, counting time, and the concentration of other elements.

1. The source strength is constant.

2. Particle size will be standardized at those fractions less than 2mm by using a sieve of 10 mesh screen.
3. Counting time can range from 100 to 400 seconds. The counting time to be used on-site will be determined during the two day XRF training that will be held in the office and in the field. The counting time needs to be selected based on the concentration of elements that is expected.

Controlling the above mentioned variables will allow a detection of 50 to 100 ppm for most analytes.

#### Calibration/Standardization

Calibration of the instrument is performed using the factory installed fundamental parameters algorithm is used for standardization and is derived from theoretical considerations for calculations of the element concentrations.

#### Computer Interface

The XRF operator will download concentration and standard deviation data from the XRF to the on-site portable IBM compatible lap-top computer on a daily basis. Down-loaded data will be backed up on 3 1/2 inch disks immediately after downloading is complete.

#### Field Procedures

##### 1.0 SAMPLE LOCATIONS

##### 1.1 Source

The Field Team Leader and XRF operator will select sample locations of solid source samples as instructed in the AMRB Hazardous Materials Inventory SAP.

##### 1.2 Migration Pathways

The Field Team Leader will select sample locations in migration pathways (solid matrix only) that originate from a source. If a drainage pathway is evident, the sample locations will typically be 500 and 1000 feet from the source. Samples will be collected from surface to six inches depth at each station.

##### 1.3 Other

Split samples will be collected and analyzed from every sample collected for CLP laboratory analysis in order to establish a correlation between the field analyses and laboratory analyses.



## 2.0 SAMPLE COLLECTION

The Field Team Member will collect the XRF solid samples in a clean ziplock plastic bag from the specified location and depth.

## 3.0 SAMPLE PREPARATION

The XRF operator will sieve the sample to remove any fraction greater than 2mm by using a stainless steel sieve. If the moisture content of the sample is too great for sieving, the sample will be ground in a mortar and pestle to a comparable size.

## 4.0 SAMPLE ANALYSIS

Sample analysis will strictly follow manufacturer's instructions.

## 5.0 SAMPLE ARCHIVE

Samples that are analyzed will be archived in plastic ziplock bags for later analyses if accuracy problems become apparent during QA/QC evaluation of data.

## 6.0 SAMPLE RECORDING

The data from the XRF will be transferred to a hard copy form as sample runs are completed. The XRF has the capability to magnetically store up to 300 sets of analysis and up to 120 spectra. The XRF results will be downloaded to the computer as discussed above.

PTS-SOP-SW-01

STANDARD OPERATING PROCEDURE  
STREAM SAMPLING

Note: This sampling procedure shall be utilized to collect aqueous samples from stream channels, drainage ditches, and springs or seeps. The samples collected will be composite or grab samples depending upon the sample site. Always sample from downstream to upstream locations and stand downstream of the sample bottles to avoid stream bed solids.

1. Rinse a set of clean sample bottles (for unfiltered samples and inorganic analyses) three times with the water to be sampled. If collecting a composite sample from multiple stream segments, also rinse a deconned sampling bucket three times.
2. If the channel width is less than 5 feet across, collect grab samples from the center of the channel. If the channel width is greater than 5 feet, divide the channel into 5-foot sections and collect a composite sample at the center of each section to obtain a channel-integrated sample.
3. Submerge the sampling containers in the water, mouth pointing upstream and below the water surface. Samples shall be collected from the approximate midpoint between the stream bed and the stream surface. Take care not to collect any stream bed solids. If collecting a grab sample, fill the sample bottle, and add required preservatives according to PTS-SOP-SA-02. Secure the bottle cap tightly then proceed to Step No. 5.
4. If collecting a composite sample, pour full container into the bucket and then take the additional grabs in each of the remaining channel sections. Collect an adequate volume of water to fill all of the required bottles. Stir or swirl the contents of the bucket gently and fill each of the sample bottles for that particular sample set and add required preservatives according to PTS-SA-02.
5. Label the sample bottles with the appropriate sample tag, carefully and clearly addressing all the required categories and parameters. Record sampling information in the Inventory form and on the chain-of-custody form.

Seeps, springs and flowing adits and shafts shall be sampled as close to the subsurface discharge as possible without disturbing the bottom sediments.

PTS-SOP-GW-01

STANDARD OPERATING PROCEDURES  
ELEVATION SURVEY FOR MONITOR WELLS

1. Arrive at the site with appropriate equipment in good working condition.
2. Begin survey using a USGS elevation reference mark as a reference point. If none are available, establish an arbitrary reference point. The arbitrary reference point must be a solid fixed point that will not change throughout the project.
3. Record survey instrument readings in field note book using proper notation.
4. Survey all monitor well locations with an accuracy of  $\pm 0.01$  foot.
5. Measure three elevations for each well including:
  - a. top of the inner well casing (TOC);
  - b. top of the outer protective casing (on the lip, not the cap); and
  - c. finished concrete pad adjacent to the outer well casing.
6. Mark TOC for future water level measurements.
7. Return survey circuit to point of origin to complete the loop and determine if the survey "closed" to allowable limits of precision.

PTS-SOP-GW-02

STANDARD OPERATING PROCEDURE  
SAMPLING WITH A BAILER

1. Using clean, noncontaminating equipment, e.g., an electronic level indicator (avoid indicating paste), determine the water level in the well, then calculate the fluid volume in the casing.
2. Purge well by pumping or bailing until pH (PTS-SOP-FM-03), specific conductance (PTS-SOP-FM-05), and temperature (PTS-SOP-FM-06) have stabilized.
3. Attach a bottom discharging bailer to clean rope for lowering and raising.
4. Lower bailer slowly until it contacts water surface.
5. Allow bailer to sink slowly and fill with a minimum of surface disturbance.
6. Slowly raise bailer to surface. Do not allow bailer line to contact ground.
7. Use bottom discharge device to slowly discharge sample into appropriate containers, or pour slowly from top of bailer.
8. Repeat Steps 2 through 5 as needed to acquire sufficient volume.
9. Preserve the sample, if necessary.
10. Check that a Teflon liner is present in cap if one is required. Secure the cap tightly.
11. Label the sample bottle with an appropriate tag. Be sure to complete the tag with necessary information. Record the information in the field logbook and complete all chain-of-custody documents.
12. Place the properly labeled sample bottle in an appropriate carrying container maintained at 4°C throughout the sampling and transportation period.
13. Bailer will be thoroughly decontaminated after each use according to SOP-DE-02.



**PTS-SOP-GW-03**

**STANDARD OPERATING PROCEDURE  
DEPTH TO WATER LEVEL MEASUREMENTS**

1. Arrive at site with proper equipment, fully decontaminated and in working order.
2. Place water level indicator down the well and measure depth using the measure point marked on the well casing.
3. If using chalked tape, coat the lower three to five feet of tape with chalk and lower into well. Listen for weight to contact water and lower tape an additional 0.5 foot. Record measure point and pull tape carefully from well. Read the wetted chalk mark and record. Subtract the wetted chalk mark from the measure point for true depth to water.
4. Decontaminate all equipment before re-use.

PTS-SOP-S-01

STANDARD OPERATING PROCEDURE  
SOIL SAMPLING

Biased Sampling

1.0 SURFACE SOIL SAMPLING

Surface sampling under biased conditions may be selected after considering factors such as type of contaminant, length of time the area has been contaminated, the type of soil and the past use of the area. Surface soil sampling usually includes the upper six inches of soil.

Surface Sampling Techniques and Equipment

1.1 Grab Sample

The most desirable sample collection device would be the soil probe (oakfield tube, king tube). This device allows uniform depth. Alternative sample collection devices include stainless steel scoops or trowels and disposable teflon trowels. These devices often produce inconsistent depths. The following procedure is designed to be used to collect a surface soil sample from the 0-2 inch horizon. These procedures may be modified in the field based on field and site conditions after appropriate annotations have been made in the field log book. These procedures are not to be used when sampling for volatile organic compounds.

- 1.1.1 Locate the site as directed in the appropriate sampling and analysis plan.
- 1.1.2 Dig a 12-inch square pit to a depth of approximately 8 inches. If an organic layer is present, this layer will be peeled back.
- 1.1.3 Place a stainless steel bowl in the pit and collect a sample by scraping the face of the pit from the mineral soil (0-2 inch interval) with a stainless steel spoon.
- 1.1.4 Remove all coarse fragments greater than 0.5 inches from the bowl. Mix the remaining sample in the bowl with a stainless steel spoon.
- 1.1.5 Transfer the soil sample directly into the appropriate sample container according to PTS-SOP-SA-01 and store in a cooler at 4 degrees celsius or less. Retain approximately 30 grams of the sample in a small decontaminated container such as a sealable plastic bag. This small sample will be used at the field laboratory to measure soil pH and conduct the XRF analysis.

- 1.1.6 Record appropriate information about the sample collection in the field logbook.
- 1.1.7 Decontaminate sampling tools according to procedures outlined in PTS-SOP-DE-02.

## 1.2 Composite Sampling

- 1.2.1 The most desirable method of compositing soil subsamples is with a large plastic or canvas sheet. The subsamples are mixed in the center of the sheet. Each corner is pulled up and toward the diagonally opposite corner. This process is done from each corner. After the soil is mixed, it is again spread out on the cloth into a relatively flat pile. The pile is quartered. A small scoop is used to collect small samples from each quarter until the desired amount of soil is acquired. Note: High concentrations of organic chemicals in soils can react with the plastic sheet.
- 1.2.2 Subsamples are often collected in a five-point (star) pattern. At each point, a subsample of a predetermined depth is collected. The diagonal distance between points is commonly ten feet depending on the area of soil homogeneity.
- 1.2.3 Subsamples can also be collected in a three-point (triangular) pattern. At each point, a subsample of predetermined depth is collected. The diagonal distance between the points is commonly ten feet depending on the area of soil homogeneity.

## 2.0 SUBSURFACE SOIL SAMPLING

The need for biased sampling of subsurface soils should be evaluated by considering factors such as the precipitation, the type of soil and the length of time the site has been contaminated. If precipitation has moved contaminants into lower soil horizons, subsurface sampling may be appropriate. Subsurface sampling includes soil depths from 1 foot to 25 feet.

### Subsurface Sampling Techniques and Equipment

Subsurface sampling can also be composite or grab sampling similar to surface sampling techniques.

## 2.1 Shallow Subsurface Sampling

- 2.1.1 The hand auger may be used to collect subsurface samples up to four or five feet in depth. The auger is twisted into the soil. The auger destroys the soil's cohesive structure and stratigraphic character.

- 2.1.2 The in situ soil recovery auger may be used to collect subsurface samples up to five feet. The auger accommodates a liner and provides fast cutting of the soil with very little soil disturbance.

## 2.2 Deep Subsurface Sampling

- 2.2.1 A power auger mounted on a truck or trailer, a well drilling rig, or a backhoe can be used for sampling up to 25 feet or more in depth.



PTS-SOP-S-03

STANDARD OPERATING PROCEDURE  
SEDIMENT SAMPLING FROM STREAMS, PONDS, AND LAKES

Very simple techniques can usually be employed for sediment sampling. Most samples will be grab samples, although sometimes sediment taken from various locations may be combined into one sample to reduce the amount of laboratory support required. Suggested techniques include the following:

1. In small, low flowing streams or near the shore of a pond or lake, a sample container may be used to scrape up the sediments.
2. To obtain sediments from larger streams or farther from the shore of a pond or lake, a teflon beaker attached to a telescoping pole by means of a clamp may be used to dredge sediments. In most cases, a number of sediment samples should be collected along a cross-section of a river or stream in order to characterize the bed material adequately. A common practice is to sample at quarter points along the cross-section of the site selected. When the sampling technique or equipment requires that the samples be extruded or transferred at the site, they can be combined into a single composite sample. However, samples of dissimilar composition should not be combined, but should be stored for separate analysis.
3. To obtain sediments from rivers or in deeper lakes and ponds, a spring loaded sediment dredge or benthic sampler may be used by lowering the sampler to the appropriate depth with a rope. The sediments thus obtained are placed into the sample container. When collecting sediment samples in lakes, ponds, and streams the site should be approximately at the center of the water mass. This is particularly true for reservoirs that are formed by the impoundment of rivers or streams. Generally, the coarser-grained sediments are deposited near the headwaters of the reservoirs, and the bed sediments near the center of the water mass will be composed of fine-grained materials. The shape, inflow pattern, bathymetry, and circulation must all be considered when selecting sediment sampling sites in lakes or reservoirs. In rivers or streams, fine-grained sediments are deposited on the outside of bends and downstream from islands or obstructions.
4. The sampling device should be decontaminated between locations as per PTS-SOP-DE-02.

**APPENDIX C**

**AMRB HAZARDOUS MATERIALS INVENTORY  
EQUIPMENT AND SUPPLIES LIST**



## EQUIPMENT AND SUPPLIES

### PERSONAL EQUIPMENT

- Pocket knife
- Rain gear
- Sun screen and hat
- Mosquito repellent
- Waders
- Steel-toed boots
- Mucker Boots
- Clothing-variety
- Emergency food supply

### OTHER EQUIPMENT

- First Aid Kit
- Portable radio
- Fire extinguisher
- Bear repellent spray
- Video camera
- Video tapes
- 35mm camera
- Slide Film
- Maps
- Inventory form
- Compass (Brunten)
- Clinometer
- Hip Chain
- Calculator
- Pencils, pens, scale,
- map wheel, protractor
- Flashlight/batteries
- Rock hammer
- Water jug
- Tape measure, 30 m (100 feet) long
- Hi-lift jack
- Assorted mechanic's tools
- Bow saw or chain saw
- Rope, 3/8" diameter (100 feet)
- Tire chains
- Tow chain
- 4X4 Truck
- Back packs
- Batteries & charger

### SAFETY SUPPLIES

- Surgical gloves
- Tyvecs
- MSA or Wilson full-face respirators, with combination cart.

### SAMPLING EQUIPMENT

- Spoons
- Disposable scoops
- Soil auger/wrenches
- Shovel
- Pickax
- Stop watch
- 45 micron millipore filters
- Hand vacuum pumps
- Bailers
- Preservatives
  - $\text{HNO}_3$
  - $\text{H}_2\text{SO}_4$
  - $\text{NaOH}$
- Sample containers
- Coolers & packing
- Vermiculite
- 1000 ml plastic beakers
- Chain-of-Custody forms
- Sample bottle labels
- Custody seals

### SAMPLING FIELD METERS/SUPPLIES

- Portable pH meter, with pH and Eh probes
- Calibration solutions
- Geiger counter or scintillometer
- Portable Specific Conductivity meter
- Mechanical flow meter
- Spectrace 9000 XRF
  - ziplock bags
  - XRF cups and film
  - Standards
- Laptop Computer
- Water level indicator
- Field Alkalinity Kit
- Soil pH Meter

### DECON SUPPLIES

- Squirt bottles
- Buckets (plastic)
- Brushes
- Liquinox
- Tap water
- Distilled water
- 1:10  $\text{HNO}_3$  for Decon
- Heavy duty plastic bags
- Aluminum foil





**FINAL**  
**QUALITY ASSURANCE PROJECT PLAN**  
**FOR THE**  
**ABANDONED MINES**  
**HAZARDOUS MATERIALS INVENTORY**

**Abandoned Mine Reclamation Bureau  
Montana Department of State Lands  
1625 11th Avenue  
Helena, Montana 59620**

**JUNE 1993**



**FINAL**  
**QUALITY ASSURANCE PROJECT PLAN**  
**FOR THE**  
**ABANDONED MINES HAZARDOUS MATERIALS INVENTORY**

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**JUNE 1993**





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## 1.0 INTRODUCTION

This document was prepared for the Montana Department of State Lands/Abandoned Mines Reclamation Bureau (MDSL/AMRB) by Pioneer Technical Services, Inc., (Pioneer) and Thomas, Dean & Hoskins, Inc., (TD&H) under the Engineering Services Agreement DSL-AMRB No. 004 for FY92/93. The purpose of the hazardous materials inventory is to collect chemical and physical data at abandoned mine sites that have the potential to impact human health and the environment.

The Abandoned Mines Hazardous Materials Inventory will begin June 1, 1993 and proceed to completion; approximately 10 weeks to 15 weeks. The logistics includes two field sampling teams of three persons each. Each field team will have a field team leader, a field sampler, and a X-Ray Fluorescence (XRF) Spectrometer operator. The field team leaders will rotate among three Pioneer principals allowing one principal to remain in the office to coordinate data processing. Each field sampling team will perform at separate sites that may or may not be in close proximity.

Hazardous materials at abandoned mine sites are regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. All CERCLA activities are required to be under the control of a centrally managed quality assurance (QA) program. QA is defined as the integrated program for ensuring reliability of monitoring and measurement data. The QA program requires the generation of a site or project specific Quality Assurance Project Plan (QAPjP).

This QAPjP describes quality assurance for the Abandoned Mines Hazardous Materials Inventory. The QAPjP is a supporting document for the Sampling and Analysis Plan (SAP; Pioneer, 1993a), Laboratory Analytical Protocol (LAP; Pioneer, 1993b), and the Health and Safety Plan (Pioneer, 1993c).

The QAPjP contains 12 sections including introduction, data quality objectives, quality assurance objectives, sampling procedures, sample custody, equipment operation, analytical procedures, data reduction, corrective action procedures, audit procedures, preventative maintenance, and references.

### 1.1 PROJECT DESCRIPTION

The Abandoned Mines Hazardous Materials Inventory includes approximately 270 sites in 23 counties throughout Montana. The topography will range from gently sloping land in floodplains to very steep mountainous areas. The land has been identified as public lands (U.S. Department of Agriculture/Forest Service, U.S. Department of Interior/Bureau of Land Management, Montana



Department of State Lands, etc.) or patented lands (private). The project consists of inactive/abandoned mine sites; however, exploration may be being conducted at the sites.

Significant features at each of the sites may include tailings ponds, impoundments, and piles; waste rock dumps or piles; mine adits, pits, shafts, and dumps; miscellaneous buildings (and associated asbestos) and structures; roads; chemical or fuel storage (barrels or tanks); fencing; and, miscellaneous power supply items (poles, transformers, lines, etc.). The sites may support wildlife, domestic grazing, or aquatic life. Residential occupation of the site is not expected, but residences adjacent to sites may be encountered.

Field activities are detailed in the Sampling and Analysis Plan (Pioneer, 1993a). Some items to be performed include: water pH, flow, Eh, temperature, specific conductance, and alkalinity measurements and sampling; solid (soil, sediment, mine tailings, waste rock, etc.) pH, texture, and radioactivity measurements and sampling; x-ray fluorescence (XRF) sampling; and, mapping. Previously collected data are not covered under this QAPjP.

## 1.2 PROJECT ORGANIZATION AND RESPONSIBILITIES

The members associated with the Abandoned Mines Hazardous Materials Inventory field sampling are listed below with their titles and responsibilities.

### MDSL Project Officer - Earl McCurley, MDSL

The MDSL Project Officer monitors the performance of the contractor. The MDSL reviews and approves QA measures. The MDSL Project Officer consults with the Quality Assurance Manager and Field Project Manager on deficiencies and aids in the finalization of the resolution action.

### Field Project Manager - Bill Bullock, Pioneer

The Field Project Manager will be responsible for consulting with the Quality Assurance Manager on deficiencies and finalizing the resolution action.

### Quality Assurance Manager - Meg Babits, Pioneer

The Quality Assurance Manager will be the leader of the data review, data validation, and auditing requirements. The Quality Assurance Manager will be responsible for discovering QA problems and report problems immediately to the Field Project Manager. The Quality Assurance Manager will provide written reports to the MDSL Project Officer on data quality with each data set.

Data Validator - Dave Tuesday, Pioneer

Responsible for providing assistance to the Quality Assurance Manager on data validation, evaluation, and interpretation.

Laboratory Quality Assurance Manager - Subcontractor

The Laboratory Quality Assurance Manager is provided a copy of the QAPjP to ensure that appropriate procedures are followed during sample analysis and data package preparation.

Field Team Members - Julie Flammang and Jodi Belanger - Pioneer;  
Taylor Pierson - TD&H

Responsible for implementation of the sampling procedures, sample custody, field equipment operation, maintenance, calibration, and standardization. Responsible for data management including data base construction and data entry after data have been analyzed and validated.

XRF OPERATORS - Dawn Clark and Mike Lasher - Pioneer

Responsible for conducting field analyses with XRFs.

XRF SUPPORT CHEMISTS - Subcontractor

Responsible for conducting QA/QC on the XRF field data and maintaining and trouble-shooting instruments.

## 2.0 DATA QUALITY OBJECTIVES

Data quality objectives (DQOs) are qualitative and quantitative statements that specify the quality of the data required to support CERCLA activities. DQOs for the Abandoned Mines Hazardous Materials Inventory were developed using the process outlined in "Data Quality Objectives for Remedial Response Activities, Development Process" (U.S Environmental Protection Agency (EPA), 1987).

Table 1 presents DQOs for the project. Included in Table 1 is the measurement, the location of that measurement, the analysis method, the sample media, and the analytical support level.

The analytical support levels are the analytical options available to support data collection activities. There are five general levels that are distinguished by the types of technology, documentation use, and degree of sophistication. The levels follow.

TABLE 1

**SUMMARY OF DATA QUALITY OBJECTIVES  
ABANDONED MINES HAZARDOUS MATERIALS INVENTORY**

| MEASUREMENT                                      | LOCATION | ANALYSIS METHOD  | ANALYTICAL<br>SUPPORT LEVEL | MEDIA      | DATA USE        |
|--|----------|--|-----------------------------|------------|-----------------|
| TAL  | Lab      | CLP SOW  | IV                          | SS, SW, GW | SC, RA, EA, ED  |
| Sulfur fractions and<br>Neutralization Potential | Lab      | Modified EPA 600/2-78-054 and<br>EPA-670/2-74-070 OAMS and SWQ | III                         | SS         | SC, EA, ED      |
| SMP Buffer                                       | Lab      | 12-3.4.4.1 MSA   | III                         | SS         | SC, EA, ED      |
| Exchangeable Acidity                             | Lab      | 9-4.1 MSA  | III                         | SS         | SC, EA, ED      |
| Asbestos   | Lab      | 40 CFR Ch.1  | III                         | Asbestos   | SC              |
| Particle Size                                    | Lab      | Method D421 ASTM   | III                         | SS         | SC              |
| Cation Exchange Capacity                         | Lab      | Method 9081 SW-846   | III                         | SS         | SC              |
| TDS  | Lab      | Method 160.1 CAWW  | III                         | SW, GW     | SC, RA, EA, ED  |
| Hardness   | Lab      | Method 130.2 CAWW  | III                         | SW, GW     | SC, RA, EA, ED  |
| Alkalinity                                       | Field    | Manufac. Instruct.   | II                          | SW, GW     | SC              |
| XRF  | Field    | Manufac. Instruct.   | II                          | SS, GW     | SC              |
| Sulfate  | Lab      | Method 9038 SW-846   | IV                          | SW, GW     | SC, RA, EA, ED  |
| Nitrate/Nitrite                                  | Lab      | Method 353.3 CAWW  | III                         | SW, GW     | SC              |
| Chloride   | Lab      | Method 325.3 CAWW  | IV                          | SW, GW     | SC, RA, EA, EDs |
| Specific Conduct.                                | Field    | Manufac. Instruct.   | II                          | SW, GW     | SC              |
| pH/ Eh   | Field    | Manufac. Instruct  | II                          | SW, GW     | SC              |

SS - Soil  
 SW - Surface Water  
 GW - Groundwater  
 XRF - X-ray fluorescence  
 TAL - Target Analyte List; from the EPA Contract Lab Program (CLP) SOW (EPA, 1990); only some of these analytes will be analyzed.  
 CAWW - Methods for Chemical Analysis of Water and Wastes (EPA, 1984).  
 SWQ - Mine Spoils Potentials for Soil and Water Quality (EPA, 1974).  
 OAMS - Field and Laboratory Methods Applicable to Overburden and Minesoils (EPA, 1978).  
 SC - Site characterization  
 RA - Risk assessment  
 EA - Evaluation of alternatives  
 ED - Engineering design  
 TDS - Total dissolved solids  
 SW-846 - Test methods for Evaluating Solid Waste - Physical/Chemical Methods, SW-846 (EPA, 1986).  
 MSA - Methods of Soil Analysis Part 2: Chemical and Microbiological Properties (SSSA, 1982).



Level V - Nonstandard methods. Analyses that may require method modification and/or development. Analyses performed by the EPA CLP under a Special Analytical Service (SAS) request are considered Level V.

Level IV - EPA CLP Routine Analytical Service (RAS). This level is characterized by rigorous QA protocols and documentation and provides qualitative and quantitative analytical data. Some commercial laboratories provide this level data.

Level III - Laboratory analysis using methods other than EPA CLP RAS methods. This level is used primarily in support of engineering studies using standard EPA approved procedures. Some procedures may be equivalent to CLP RAS without the CLP requirements for documentation.

Level II - Field analysis. This level is characterized by the use of portable analytical instruments that can be used on-site or in mobile laboratories stationed near the site.

Level I - Field screening. This level is characterized by the use of portable instruments that can provide real-time data to assist in the optimization of sampling point locations and for health and safety support.

### 3.0 QUALITY ASSURANCE OBJECTIVES

The ability of data to meet DQOs is evaluated with a precision, accuracy, representativeness, completeness, and comparability (PARCC) statement. A PARCC statement is generated during data evaluation (after data has been validated).

#### 3.1 PRECISION

Precision is the amount of scatter or variance that occurs in repeated measurements of a particular analyte. Precision acceptance and rejection is based on the relative percent difference (RPD) of the laboratory and field duplicates. For example, perfect precision would be a 0% RPD and for total metals acceptable precision would be a RPD of plus or minus 20% in water. Precision requirements are derived from the CLP SOW (EPA, 1990). Precision will only be assessed for the laboratory analysis of certain metals in the TAL; the procedures for calculating precision are presented in Appendix A. The range of acceptable RPDs for precision is presented in Table 2.



**TABLE 2**  
**PRECISION, ACCURACY, AND COMPLETENESS REQUIREMENTS**  
**ABANDONED MINES HAZARDOUS MATERIALS INVENTORY**

|     | PRECISION |       | ACCURACY |          | COMPLETENESS |
|-----|-----------|-------|----------|----------|--------------|
|     | SOLID     | WATER | SOLID    | WATER    |              |
| TAL | 35%       | 20%   | 75%-125% | 75%-125% | 90%          |

### 3.2 ACCURACY

Accuracy is measured as the ability of the analytical procedure to determine the actual or known quantity of a particular substance in a sample. The standard deviation (SD) of the laboratory matrix spike will be used to generate overall accuracy statements for inorganic data. Accuracy acceptance or rejection is based on the percent recovery (% R) of the laboratory matrix spike. For example, perfect recovery would be 100% and an acceptable range for total metals would be 75% to 125% in water. Accuracy requirements are derived from the CLP SOW (EPA, 1990). Accuracy will only be assessed for the laboratory analysis of certain metals in the TAL; the procedures for calculating accuracy are presented in Appendix A. The range of acceptable RPDs for accuracy is presented in Table 2.

### 3.3 REPRESENTATIVENESS

The objective in addressing representativeness is to assess whether information obtained during the investigation accurately represents the site conditions. Laboratory water blanks, field water equipment rinsate samples, and field water blanks are used to assess representativeness.

### 3.4 COMPLETENESS

The objective in addressing completeness is to assess whether enough data have been collected and enough data are valid (see Section 8.0) to meet the investigation needs. Completeness is assessed by comparing the number of valid sample results to the number of samples collected. The completeness targets for this investigation are presented in Table 2.

### 3.5 COMPARABILITY

The objective in addressing comparability is to assess whether one set of data can be compared to another set of data. Comparability is assessed by determining if an EPA approved analysis method was used, if values and units are sufficient for the database, if

specific sampling points can be established and documented, and if field collection methods were similar. Specifications for laboratory methods are available in the LAP document (Pioneer, 1993b) and the SAP document (Pioneer, 1993a).

### 3.6 FIELD X-RAY FLUORESCENCE SPECTROMETER

The field portable XRF determines the concentrations of 22 elements in solid media. Precision will be assessed by submitting field duplicates to the XRF operator; acceptable precision requirements have not been determined. Accuracy will be assessed by submitting the blind field standard; acceptable accuracy requirements have not been determined.

In addition, the XRF data will be compared to the lab data using appropriate statistical procedures.

## 4.0 SAMPLING PROCEDURES

The quality of the data collected in an environmental study depends on the quality of the sampling activities. Detailed procedures for sample collection and handling are specified and documented in the SAP (Pioneer, 1993a) and corresponding SOPs. Procedures presented in the SAP (Pioneer, 1993a) are in accordance with EPA accepted procedures.

### 4.1 FIELD LOGBOOK

The field logbook is the site-specific inventory form and it is the written record of all data, observations, field equipment calibrations, samples, and chain-of-custody. Since there is a strong potential for litigation in CERCLA investigations, the site-specific inventory form will be a legal document. All entries will be in waterproof ink. Any mistakes will be lined out with a single line and initialed by the person making the correction. At a minimum the form entry shall include:

- purpose of sampling;
- location and description of sampling point;
- identification of sampling crew;
- type, number, preservative, and volume of sample;
- date and time of sampling;
- date and time of shipping;
- weather;
- field measurements; and,
- deviations from SOPs.

### 4.2 SAMPLE CONTROL, DOCUMENTATION, AND SHIPPING

The SOPs for sample handling, shipping, and related matters are in the SAP (Pioneer, 1993a). Samples will be packaged and shipped

according to the U.S. Department of Transportation (DOT) and EPA regulations. The purpose of these procedures is to maintain the integrity of all samples during collection, transportation, analysis, and reporting.

#### 4.3 FIELD QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

The following types of blind quality assurance/quality control (QA/QC) samples will be collected in the field and shipped to the lab.

##### 4.3.1 Field Duplicate

The field duplicates are co-located samples collected identically and consecutively over a minimum period of time. These samples are prepared by collecting an aliquot of subdivided samples after appropriate mixing and homogenization has been performed. Field duplicates can be provided to another party at their request (split sample). Field duplicates will be collected at a minimum frequency of 1 per 20 samples for water media only because solid media is too heterogenous. Field duplicates will be used to assess precision (see Section 3.1).

##### 4.3.2 Equipment Rinsate Blank

An equipment rinsate blank consists of deionized water poured through decontaminated field equipment. An equipment rinsate will be prepared at a minimum frequency of 1 per 20 samples for the water media only because disposable soil sampling equipment is used to prevent cross-contamination. Equipment rinsate blanks will be used to assess representativeness (see Section 3.3).

##### 4.3.3 Field Blank

The field blank is prepared by pouring deionized water into the appropriate sample containers and includes all appropriate preservative chemicals. A field blank will be prepared at a minimum frequency of 1 per 20 samples for the water media only because contamination introduced by improper field activities is more easily detected in the water matrix. Field blanks provide a measure of potential errors that can be introduced from sources other than the sample. Field blanks will be used to assess representativeness (see Section 3.3).

##### 4.3.4 Field Background

The field background sample provides local concentrations of analytes. The requirements for sample collection procedures, collection conditions, and collection frequency will be specified in the SAP (Pioneer, 1993a), probably involving at least one per media per district.



## 5.0 SAMPLE CUSTODY

### 5.1 CHAIN-OF-CUSTODY

A required part of any sampling and analytical program is the integrity of the sample from collection to data reporting. This includes the ability to trace the possession and handling of samples from the time of collection through analysis and final disposition. This documentation of the sample's history is referred to as chain-of-custody (COC). A sample is considered to be under a person's custody if it is in a person's physical possession, in view of the person after taken possession, or secured by that person so that no one can tamper with the sample.

The components of the field COC (COC form, labels, and custody seals) and lab COC (COC record, sample login/logout, sample storage records, and disposal records) are described in this section.

### 5.2 CHAIN-OF-CUSTODY FORM

A COC form will be completed and accompany every sample. The form includes the following information:

- Project code;
- Project name;
- Samplers signature;
- Sample identification;
- Date sampled;
- Time sampled;
- Analysis requested;
- Remarks;
- Relinquishing signature, data, and time; and,
- Receiving signature, date, and time.

### 5.3 SAMPLE LABELS

Sample labels are necessary to prevent misidentification of samples. Self-adhesive labels are used and include the following information:

- Sample identification;
- Sampler's initials;
- Analysis requested;
- Sampling date;
- Sampling time; and,
- Preservative.

### 5.4 CUSTODY SEALS

Custody seals are used to detect unauthorized tampering with samples following sample collection up to the time of analysis. Custody seals will be applied to the shipping containers when the samples are not in the sampler's custody.



## **5.5 LABORATORY CUSTODY**

Laboratory custody will conform to procedures established for the CLP. These procedures include:

- designation of sample custodian;
- correct completion of the COC form, recording of sample identification numbers, and documentation of sample condition upon receipt;
- laboratory sample tracking and documentation procedures; and,
- secure sample storage.

The sample will be delivered to the lab for analysis in order to perform requested analyses within the specified allowable holding times. The sample will be delivered to the person in the lab who is authorized to receive samples (lab sample custodian).

## **6.0 EQUIPMENT OPERATION, MAINTENANCE, CALIBRATION, AND STANDARDIZATION**

All field and lab equipment will be operated, maintained, calibrated, and standardized in accordance with the EPA and manufacturer's recommended procedures. The SOPs in the SAP (Pioneer, 1993a) contain the field equipment operation, maintenance, calibration, and standardization procedures. The LAP (Pioneer, 1993b) contains the laboratory equipment operation, maintenance, calibration, and standardization procedures.

## **7.0 ANALYTICAL PROCEDURES**

Methods to be employed and the references are summarized in the LAP (Pioneer, 1993b). Laboratory analysis of samples collected during the course of this study will be performed by labs that have established protocols and QA procedures that meet or exceed EPA guidelines. EPA approved methods will be used for all parameters that have them.

## **8.0 DATA REDUCTION, VALIDATION, DATA EVALUATION, AND REPORTING**

### **8.1 DATA REDUCTION**

Data reduction is performed in lab the on the lab data; it is the result of grouping similar QC samples and calculating and reporting their recoveries. When EPA methods are used, the applicable data reduction procedures in the EPA method are used.

## 8.2 DATA VALIDATION

Data validation is performed on the lab data in the lab and in the office after data reduction is complete. The lab validates data by reporting concentrations with "result qualifiers" (inorganics), if necessary. Table 3 presents result qualifiers that may be used; result qualifiers are derived from the CLP SOW (EPA, 1990).

The office validates data by reporting concentrations with "data qualifiers" (inorganics). Table 4 presents data qualifiers that may be used; data qualifiers are derived from the "Functional Guidelines for Evaluating Inorganics Analysis," (EPA, 1988).

Knowing the limitations of the data assists the data user when making interpretations. Data with limitations are usable for evaluation as long as the limitations are considered. Data is divided into three levels after data validation has been completed. The three levels are: enforcement quality (unrestricted use), screening quality (restricted use), and unusable. These data levels are related to the analytical support levels described in Section 2.0.

The field XRF has some internal QA/QC performed including a calibration curve generated daily and a standard analyzed 1 per 10 samples. Field QA/QC analyzed with the XRF includes the field duplicates. Also, the XRF will analyze every sample that is submitted for CLP analysis. The above QA/QC will allow a limited data validation to be performed.

Data validation of other field data (pH meter and SC meter) is not possible because these data have very limited statistical control limits. Professional judgement is required to assess the impact of field QC on the overall quality and usability of the field data. The field blanks are the most straight forward QC checks to assess. Evidence of cross contamination can be ascertained without much subjective judgement and the options for corrective action are clear.

## 8.3 DATA EVALUATION

Data evaluation is performed in the office after data validation is complete. Data evaluation is the generation of the PARCC statement (see Section 3.0) that assesses the data meeting the DQOs.

## 8.4 DATA REPORTING

Data reporting begins with transferring the validated analytical results and field measurements to the computerized database. Pioneer will be using DBase IV software for transferring data to

TABLE 3  
RESULT QUALIFIERS

- 1) C (Concentration) qualifier -- Enter "B" if, the reported value was obtained from a reading that was less than the Contract Required Detection Limit (CRDL) but greater than or equal to the Instrument Detection Limit (IDL). If the analyte was analyzed for but not detected, a "U" must be entered.
- 2) Q qualifier
  - E - The reported value is estimated because of the presence of interference.
  - M - Duplicate injection precision not met.
  - N - Spike sample recovery not within control limits.
  - S - The reported value was determined by the Method of Standard Additions (MSA).
  - W - Post-digestion spike for Furnace AA analysis is out of control limits (85-115%), while sample absorbance is less than 50% of spike absorbance.
  - \* - Duplicate analysis not within control limits.
  - + - Correlation coefficient for the MSA is less than 0.995.

Entering "S", "W", or "+" is mutually exclusive. No combination of these qualifiers can appear in the same field for an analyte.
- 3) M (Method) qualifier -- Enter:
  - "P" for ICP
  - "A" for Flame AA
  - "F" for Furnace AA
  - "CV" for Manual Cold Vapor AA
  - "AV" for Automated Cold Vapor AA
  - "AS" for Semi-Automated Spectrophotometric
  - "C" for Manual Spectrophotometric
  - "T" for Titrimetric
  - "NR" if the analyte is not required to be analyzed.

## TABLE 4

### DATA QUALIFIERS

- U - The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.
- J - The associated value is an estimated quantity.
- R - The data are unusable. (Note: Analyte may or may not be present.)
- UJ - The material was analyzed for, but was not detected. The associated value is an estimate and may be inaccurate or imprecise.



the AMRB. Data reporting continues with a printout of the analytical results and field measurements database and the interpretation of the analytical results and field measurements. The QC Summary Results, validation summaries, and computerized database will be presented to the MDSL/AMRB at the completion of the project.

#### **9.0 CORRECTIVE ACTION PROCEDURES**

Field equipment malfunctions are identified immediately and will be corrected by the Field Team Leaders. Field QC samples outside of the control limits presented in Table 2 will be handled in the data validation process by assigning data or result qualifiers. Lab equipment malfunctions are handled by the chemist according to the EPA analytical method specifications. Lab QC samples (calibration samples, method blanks, matrix spike samples, laboratory control samples, and lab duplicates) will be handled according to the EPA analytical method specifications. Method specifications are presented in the LAP (Pioneer, 1993b).

#### **10.0 AUDIT PROCEDURES**

An internal audit of all field procedures will be performed by the Quality Assurance Manager prior to any field work. The internal audit will include a review of procedures selected for the sampling program, a review of the QA/QC samples required, and a review of training requirements. The lab is required to have written procedures addressing internal QA/QC.

An external audit of all field procedures will be performed at the discretion of the MDSL Project Officer. External audit reports with recommended corrective action will be submitted by the MDSL Project Officer to the Quality Assurance Manager and the Field Project Officer.

#### **11.0 PREVENTATIVE MAINTENANCE**

Preventative maintenance of equipment is essential if project resources are to be used in a cost effective manner. Critical spare parts will be available in the field. These spare parts include pH buffer solutions, batteries, extra meter probes, film, SC standards, and extra respirator cartridges.

## 12.0 REFERENCES

- Pioneer, 1993a. Sampling and Analysis Plan for the Abandoned Mines Hazardous Materials Inventory.
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**APPENDIX A**  
**PROCEDURES FOR CALCULATING**  
**ACCURACY AND PRECISION**





## PROCEDURES FOR CALCULATING ACCURACY

1. Calculate the percent recovery of the lab matrix spike:

$$\% \text{ Recovery of Spike} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

where:

SSR = Spiked Sample Results;  
SR = Sample Results; and  
SA = Spike Added.

Perfect accuracy would be 100 percent recovery.

2. Calculate the standard deviation of all pairs.

$$SD = \left( \frac{\sum (\text{Recovery}_i - \text{Recovery}_{\text{avg.}})^2}{n-1} \right)^{1/2}$$

where:

Recovery<sub>i</sub> = individual recoveries;  
Recovery<sub>avg.</sub> = average recovery; and  
n = number of values.

3. To validate recovery data, the individual recoveries are compared with the average recovery value to identify individual values that lie outside the range of reasonableness. Chauvenet's criterion is used to identify individual recovery values that lie outside the range. To use Chauvenet's criterion, the screening variable is computed for recovery values that are suspected of lying outside the range of reasonableness.

$$\text{Screening Variable} = (\text{Recovery}_i - \text{Recovery}_{\text{avg.}}) / \text{SD}.$$

The calculated screening variable is then compared to the maximum allowable value (found in Table A-1, Chauvenet's Criterion) for the appropriate number of recovery determinations. The suspect recovery value is set aside (set aside values are called outliers) if the calculated screening variable equals or exceeds the maximum allowable value.

If outliers are identified using Chauvenet's criterion, a new average recovery and a new standard deviation are recalculated using the remaining good value, and Chauvenet's criterion is reapplied. This procedure is repeated until all surviving recovery values pass Chauvenet's criterion. (Usually one

Chauvenet's Criterion:

TABLE A-1

CHAUVENET'S CRITERION  
FOR REJECTING A SUSPECTED VALUE<sup>a</sup>

| Number of Samples<br><u>n</u> | Maximum Allowable Values for<br>(Recovery <sub>i</sub> - Recovery <sub>avg.</sub> ) / SD <sup>b</sup> |
|-------------------------------|---|
| 3                             | 1.901   |
| 4                             | 1.983   |
| 5                             | 2.015   |
| 6                             | 2.111   |
| 7                             | 2.164   |
| 8                             | 2.195   |
| 9                             | 2.214   |
| 10                            | 2.228   |
| 11                            | 2.279   |
| 12                            | 2.318   |
| 13                            | 2.348   |
| 14                            | 2.373   |
| 15                            | 2.393   |
| 16                            | 2.409   |
| 17                            | 2.424   |
| 18                            | 2.435   |
| 19                            | 2.445   |
| 20                            | 2.454   |
| 21                            | 2.462   |
| 22                            | 2.469   |
| 23                            | 2.475   |
| 24                            | 2.480   |
| 25                            | 2.485   |
| 26                            | 2.502   |
| 27                            | 2.517   |
| 28                            | 2.530   |
| 29                            | 2.543   |
| 30                            | 2.555   |
| 40                            | 2.634   |

<sup>a</sup>Based on t distribution rather than the traditional (normal) distribution.

<sup>b</sup>Individual Recovery = Recovery<sub>i</sub>  
Average Recovery = Recovery<sub>avg.</sub>

TABLE A-2  
DISTRIBUTION OF t

| Number<br>of<br>Sample | Degrees<br>of<br>Freedom | Complementary Probability (as percent) |       |       |       |       |        |        |
|------------------------|--------------------------|--|-------|-------|-------|-------|--------|--------|
|                        |                          | 50                                     | 70    | 80    | 90    | 95    | 98     | 99     |
| 2                      | 1                        | 1.000                                  | 1.963 | 3.078 | 6.314 | 2.706 | 31.821 | 63.657 |
| 3                      | 2                        | .816                                   | 1.389 | 1.886 | 2.920 | 4.303 | 6.965  | 9.925  |
| 4                      | 3                        | .765                                   | 1.250 | 1.638 | 2.353 | 3.182 | 4.541  | 5.841  |
| 5                      | 4                        | .741                                   | 1.190 | 1.533 | 2.132 | 2.776 | 3.747  | 4.604  |
| 6                      | 5                        | .727                                   | 1.156 | 1.476 | 2.015 | 2.571 | 3.365  | 4.032  |
| 7                      | 6                        | .718                                   | 1.134 | 1.440 | 1.943 | 2.447 | 3.143  | 3.707  |
| 8                      | 7                        | .711                                   | 1.119 | 1.415 | 1.895 | 2.265 | 2.998  | 3.499  |
| 9                      | 8                        | .706                                   | 1.108 | 1.397 | 1.860 | 2.306 | 3.896  | 3.355  |
| 10                     | 9                        | .703                                   | 1.100 | 1.383 | 1.833 | 2.262 | 2.821  | 3.250  |
| 11                     | 10                       | .700                                   | 1.093 | 1.372 | 1.812 | 2.228 | 2.764  | 3.169  |
| 12                     | 11                       | .697                                   | 1.088 | 1.363 | 1.796 | 2.201 | 2.718  | 3.106  |
| 12                     | 12                       | .695                                   | 1.083 | 1.356 | 1.782 | 2.179 | 2.681  | 3.055  |
| 14                     | 13                       | .694                                   | 1.079 | 1.350 | 1.771 | 2.160 | 2.650  | 3.012  |
| 15                     | 14                       | .692                                   | 1.076 | 1.345 | 1.761 | 2.145 | 2.624  | 2.997  |
| 16                     | 15                       | .691                                   | 1.074 | 1.341 | 1.753 | 2.131 | 2.602  | 2.947  |
| 17                     | 16                       | .690                                   | 1.071 | 1.337 | 1.746 | 2.120 | 2.583  | 2.921  |
| 18                     | 17                       | .689                                   | 1.069 | 1.333 | 1.740 | 2.110 | 2.567  | 2.898  |
| 19                     | 18                       | .688                                   | 1.067 | 1.330 | 1.734 | 2.101 | 2.552  | 2.878  |
| 20                     | 19                       | .688                                   | 1.066 | 1.328 | 1.729 | 2.093 | 2.539  | 2.861  |
| 21                     | 20                       | .687                                   | 1.064 | 1.325 | 1.725 | 2.086 | 2.528  | 2.845  |
| 22                     | 21                       | .686                                   | 1.063 | 1.323 | 1.721 | 2.080 | 2.518  | 2.831  |
| 23                     | 22                       | .686                                   | 1.061 | 1.321 | 1.717 | 2.074 | 2.508  | 2.819  |
| 24                     | 23                       | .685                                   | 1.060 | 1.319 | 1.714 | 2.069 | 2.500  | 2.807  |
| 25                     | 24                       | .685                                   | 1.059 | 1.318 | 1.711 | 2.064 | 2.492  | 2.797  |
| 26                     | 25                       | .684                                   | 1.058 | 1.316 | 1.708 | 2.060 | 2.485  | 2.787  |
| 27                     | 26                       | .684                                   | 1.058 | 1.315 | 1.706 | 2.056 | 2.479  | 2.779  |
| 28                     | 27                       | .684                                   | 1.057 | 1.314 | 1.703 | 2.052 | 2.470  | 2.771  |
| 29                     | 28                       | .683                                   | 1.056 | 1.313 | 1.701 | 2.048 | 2.467  | 2.763  |
| 30                     | 29                       | .683                                   | 1.055 | 1.311 | 1.699 | 2.045 | 2.462  | 2.756  |
| 31                     | 30                       | .683                                   | 1.055 | 1.310 | 1.697 | 2.042 | 2.457  | 2.750  |
| 41                     | 40                       | .681                                   | 1.050 | 1.303 | 1.684 | 2.021 | 2.432  | 2.704  |
| 61                     | 60                       | .679                                   | 1.046 | 1.296 | 1.671 | 2.000 | 2.390  | 2.660  |
| 121                    | 120                      | .677                                   | 1.036 | 1.289 | 1.645 | 1.960 | 2.326  | 2.576  |



application and one recalculation are enough.) The final average recovery and final standard deviation are calculated from the surviving recovery values. The final average recovery value is used to eliminate any bias from the laboratory data.

4. The range of uncertainty (R) in the recovery is then calculated.

$$bR = b \text{ tSD}/(n)^{1/2}$$

where:

R = range of uncertainty expressed as a percent;  
t = value of the t distribution for the selected confidence level (90 percent) and (n-1) degrees of freedom (Table A-2);  
n = number of samples; and  
SD = standard deviation.

The range of uncertainty is used in conjunction with the average recovery to determine if bias adjustments are required..

5. The completeness of accuracy data is that percentage of the total number of samples that remained after outliers are identified and set aside with Chauvenet's criterion.

## PROCEDURES FOR CALCULATING PRECISION

1. Calculate the relative percent difference (RPD) of each replicate pair:

$$RPD = \frac{|S-D|}{(SD)/2} \times 100$$

where:

RPD = relative percent difference;  
S = first sample value (original); and  
D = second sample value duplicate.

Perfect precision would result in 0 percent RPD.

2. Any RPD value exceeding the control limit of  $\pm 20$  percent (water) or  $\pm 35$  percent (soil) for inorganics or the control limits in the QAPJP for organics is evaluated as an outlier using the Dixon Q method.

### Dixon Test for Outlying Observations

This procedure has an advantage in that an estimate of the standard deviation is not needed to use it. The procedure is:

- a. rank the RPD data in order of increasing numerical value;
- b. decide which RPD value is suspect (usually the highest number);
- c. select the risk for a false rejection (Table A-3); and
- d. compute one of the following ratios (statistics):

| n                   | Ratio | If $X_n$ is suspect             |
|---------------------|-------|---------------------------------|
| $3 \leq n \leq 7$   | 10    | $(X_n - X_{n-1}) / (X_n - X_1)$ |
| $8 \leq n \leq 10$  | 11    | $(X_n - X_{n-1}) / (X_n - X_2)$ |
| $11 \leq n \leq 13$ | 21    | $(X_n - X_{n-2}) / (X_n - X_3)$ |
| $14 \leq n \leq 25$ | 22    | $(X_n - X_{n-2}) / (X_n - X_4)$ |

- e. compare the ratio (statistic) calculated with the values in Table A-3. If the calculated ratio is greater than the tabulated value, rejection may be made with the tabulated risk.
- f. Suspected outliers failing the Dixon test are rejected in an iterative process and are not used in the following precision QA statement calculations.

TABLE A-3  
VALUES FOR USE IN THE DIXON TEST FOR OUTLIERS

| <u>Statistic</u> | <u>Number of<br/>Observations, n</u> | <u>Risk of False Rejection</u> |           |           |            |
|------------------|--------------------------------------|--------------------------------|-----------|-----------|------------|
|                  |                                      | <u>0.5%</u>                    | <u>1%</u> | <u>5%</u> | <u>10%</u> |
| $t_{10}$         | 3                                    | .994                           | .988      | .941      | .886       |
|                  | 4                                    | .926                           | .889      | .765      | .679       |
|                  | 5                                    | .821                           | .780      | .642      | .557       |
|                  | 6                                    | .740                           | .698      | .560      | .482       |
|                  | 7                                    | .680                           | .637      | .507      | .434       |
| $t_{11}$         | 8                                    | .725                           | .683      | .554      | .479       |
|                  | 9                                    | .677                           | .635      | .512      | .441       |
|                  | 10                                   | .639                           | .597      | .477      | .409       |
| $t_{21}$         | 11                                   | .713                           | .679      | .576      | .517       |
|                  | 12                                   | .675                           | .642      | .546      | .490       |
|                  | 13                                   | .649                           | .615      | .521      | .467       |
| $t_{22}$         | 14                                   | .674                           | .641      | .546      | .492       |
|                  | 15                                   | .647                           | .616      | .525      | .472       |
|                  | 16                                   | .624                           | .595      | .507      | .454       |
|                  | 17                                   | .605                           | .577      | .490      | .438       |
|                  | 18                                   | .589                           | .561      | .475      | .424       |
|                  | 19                                   | .575                           | .547      | .462      | .412       |
|                  | 20                                   | .562                           | .535      | .450      | .401       |

Original reference: W.J. Dixon, "Processing Data Outliers," Biometrics, B10MA, 9(No.1): 74-89 (March 1953).

3. Calculate the relative standard deviation (RSD) of each replicate pair.

$$RSD_{\text{each pair}} = \text{SD each pair} / \text{Mean}$$

4. Calculate the RSD for all the pairs.

$$RSD_{\text{overall}} = \sqrt{\frac{\sum_{i=1}^{n-1_{\text{pair}}} RSD_{\text{each}}^2}{n-1_{\text{pair}}}}$$

5. Calculate precision as a percent.

$$\text{Precision (\%)} = \frac{t_{n-1_{\text{pairs}}} \times RSD_{\text{overall}}}{(n-1_{\text{pairs}})^{1/2}} \times 100$$

Where t is the value from the 90 percent probability level (Table A-2).

6. The completeness of precision data is that percentage of the total number of RPD values that remained after outliers are identified and set aside with Dixon's Q ratio.





**FINAL**  
**LABORATORY ANALYTICAL PROTOCOL**  
**FOR THE**  
**ABANDONED MINES**  
**HAZARDOUS MATERIALS INVENTORY**

**Abandoned Mine Reclamation Bureau  
Montana Department of State Lands  
1625 11th Avenue  
Helena, Montana 59620**

**JUNE 1993**



**FINAL**

**LABORATORY ANALYTICAL PROTOCOL  
FOR THE  
ABANDONED MINES HAZARDOUS MATERIALS INVENTORY**

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**JUNE 1993**





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## 1.0 INTRODUCTION

This document was prepared for the Montana Department of State Lands/Abandoned Mines Reclamation Bureau (MDSL/AMRB) by Pioneer Technical Services, Inc., (Pioneer) and Thomas, Dean & Hoskins, Inc., (TD&H) under the Engineering Services Agreement DSL-AMRB No. 004 for FY92/93. The purpose of the hazardous materials inventory is to collect chemical and physical data at abandoned mine sites that have the potential to impact human health and the environment.

The Abandoned Mines Hazardous Materials Inventory will begin June 1, 1993 and proceed approximately 10 to 15 weeks. The logistics includes two field sampling teams of three persons each. Each field team will have a field team leader, a field team member, and a X-ray fluorescence (XRF) spectrometer operator. The field team leaders will rotate among three Pioneer principals allowing one to remain in the office to coordinate data management and laboratory coordination as needed. Each field sampling team will perform at separate sites that may not be in close proximity.

This Laboratory Analytical Protocol (LAP) describes laboratory requirements for the Abandoned Mines Hazardous Materials Inventory. Analysis of water and solids (streambed sediments, waste rock features, tailings features, or soil) is expected. All analytical work is to follow the requirements listed in this document for the duration of the project. The LAP is a supporting document for the Abandoned Mines Hazardous Materials Inventory Work Plan (Pioneer, 1993a). Other supporting documents include the Quality Assurance Project Plan (QAPjP) (Pioneer, 1993b), the Health and Safety Plan (Pioneer, 1993c), and the Sampling and Analysis Plan (SAP) (Pioneer, 1993d) and corresponding Standard Operating Procedures (SOPs).

The LAP contains six sections including introduction, sample collection, laboratory requirements, quality assurance requirements, analytical methods, and references.

### 1.1 PROJECT DESCRIPTION

The Abandoned Mines Hazardous Materials Inventory includes approximately 270 sites in 23 counties throughout Montana. The topography will range from gently sloping land in floodplains to very steep mountainous areas. The land has been identified as public lands (U.S. Department of Agriculture/Forest Service, U.S. Department of Interior/Bureau of Land Management, Montana Department of State Lands, etc.) or patented lands (private). The project consists of inactive/abandoned mine sites, however, exploration may be being conducted at the sites.

Significant features at each of the sites may include tailings ponds, impoundments, and piles; waste rock dumps or piles; mine adits, pits, shafts, and dumps; miscellaneous buildings (and



associated asbestos) and structures; roads; chemical or fuel storage (barrels or tanks); fencing; and, miscellaneous power supply items (poles, transformers, lines, etc.). The sites may support wildlife, domestic grazing, or aquatic life. Residential occupation of the sites is not expected but residences adjacent to sites may be encountered.

Field activities are detailed in the Sampling and Analysis Plan (Pioneer, 1993d). Some items to be performed include: water pH, flow, Eh, temperature, specific conductance, and alkalinity measurements and sampling; solid (soil, sediment, mine tailings, waste rock, etc.) pH, texture, and radioactivity measurements and sampling; XRF analysis; and, mapping.

## **2.0 SAMPLE COLLECTION**

### **2.1 SAMPLE QUANTITIES**

This section describes the necessary procedures in the field to ensure proper field or lab analysis procedures can be followed. The total number of samples to be collected for the project is unknown because of the variability of the 270 sites. The Sampling and Analysis Plan (Pioneer, 1993d) for the Abandoned Mines Hazardous Materials Inventory describes when and how samples will be collected.

### **2.2 PRESERVATION AND HOLDING TIMES**

Table 1 lists the media, parameter and reference, required preservation, holding time, sample size, and sample container to be used on the project. Whenever possible, standard U.S. Environmental Protection Agency (EPA) protocols are used.

## **3.0 LABORATORY REQUIREMENTS**

A main lab will be subcontracted through TD&H and the lab will be required to meet the terms in this section. A specialized lab may be employed for unusual analysis outside the capabilities of the main lab.

### **3.1 QUALIFICATIONS AND EXPERIENCE**

The laboratory shall designate and use key personnel meeting the minimum requirements, as specified below, and comply with all terms and conditions of the contract. Experience is defined as more than 50 percent of the person's productive work time in active participation on a given task and includes the following.

1. The Inductively Coupled Plasma (ICP) emission spectroscopist responsible for work under this contract must have at least one year of experience in the operation of the ICP on soil and water samples.

TABLE 1

**SAMPLE COLLECTION, PRESERVATION, AND HOLDING TIMES  
ABANDONED MINES HAZARDOUS MATERIALS INVENTORY**

| MEDIA | PARAMETER                                      | REFERENCE   | PRESERVATION  | HOLDING TIME                             | SAMPLE SIZE | BOTTLE                     |
|-------|--|---|---|--|-------------|----------------------------|
| Solid | TAL plus cyanide                               | CLP SOW 3/90  | Ice to 4°C  | 180 days; Hg 26 days; Cyanide 12 days    | 8 oz.       | 8 oz. glass                |
| Solid | Sulfur fractions and Neutralization potential* | Modified EPA 600/2-78-054 and EPA-670/2-74-070 OAMS and SWQ | Ice to 4°C  | 30 days                                  | 4 oz.       | 4 oz.                      |
| Solid | SMP Buffer*                                    | 12-3.4.4.1 MSA  | Ice to 4°C  | 30 days                                  | 4 oz.       | 4oz.                       |
| Solid | Exchangeable Acidity*                          | 9-4.1 MSA   | Ice to 4°C  | 30 days                                  | 4 oz.       | 4oz.                       |
| Solid | Asbestos                                       | 40 CFR Ch.1   | None  | None                                     | 4 oz.       | 4 oz.                      |
| Solid | Particle size                                  | Method D421 ASTM  | None  | None                                     | 4 oz.       | 4 oz.                      |
| Solid | Cation exchange capacity (CEC)                 | Method 9081 SW-846  | None  | 7 days until drying; 8 mos. after drying | 4 oz.       | 4 oz.                      |
| Water | TAL plus cyanide                               | CLP SOW 3/90  | HNO <sub>3</sub> to pH <2; Cyanide NaOH to pH >12; Ice to 4°C | 180 days; Hg 26 days; Cyanide 12 days    | 1 L<br>1 L  | 1 L<br>Poly<br>1 L<br>Poly |
| Water | Sulfate**                                      | Method 9038 SW-846 or 375.1 CAWW                            | Ice to 4°C  | 28 days                                  | 500 ml      | 500 ml<br>Poly             |
| Water | Nitrate/Nitrite                                | Method 353.2 CAWW   | H <sub>2</sub> SO <sub>4</sub> to pH <2; Ice to 4°C           | 28 days                                  | 500 ml      | 500 ml<br>Poly             |
| Water | Chloride**                                     | Method 325.1 or 325.3 CAWW                                  | Ice to 4°C  | 28 days                                  | 500 ml      | 500 ml<br>Poly             |
| Water | Hardness                                       | Method 130.2 CAWW   | Ice to 4°C  | 28 days                                  | 1 L         | 1 L<br>Poly                |
| Water | TDS  | Method 160.1 CAWW   | Ice to 4°C  | 7 days                                   | 500 ml      | 500 ml<br>Poly             |

- \* - Sulfur fractions, Neutralization potential, Exchangeable acidity, and SMP buffer are used to determine lime requirement and can be analyzed from the same 4 oz. bottle.
- \*\* - Chloride and Sulfate can be analyzed from the same 500 ml Poly.
- TAL - Target Analyte List; from the EPA Contract Lab Program (CLP) SOW (EPA, 1990); only some of these analytes will be analyzed, selected on a case-by-case basis.
- CAWW - Methods for Chemical Analysis of Water and Wastes (EPA, 1984).
- SW-846 - Test Methods for Evaluating Solid Waste-Physical/Chemical Methods, SW-846 (EPA, 1986).
- OAMS - Field and Laboratory Methods Applicable to Overburden and Minesoils (EPA, 1978).
- SWQ - Mine Spoils Potentials for Soil and Water Quality (EPA, 1974).
- MSA - Methods of Soil Analysis Part 2: Chemical and Microbiological Properties (SSSA, 1982).
- ASTM - American Society for Testing and Materials (ASTM, 1985).

2. The Furnace Atomic Absorption (AA) spectroscopist responsible for the work on this contract must have at least one year of experience in the operation of a furnace AA on soil and water.
3. The Hydride Generation AA and Cold Vapor AA (CVAA) spectroscopist responsible for work on this contract must have specific training in hydride applications and at least one year experience in the operation of hydride AA and CVAA.
4. The inorganic sample preparation expert performing sample preparation for this contract must have at least three months of experience in the preparation of environmental samples for ICP and AA analysis.
5. The analyst or technician responsible for determining soil pH on the contract must have at least six months experience in the technique and instrumentation.
6. The sample custodian, who is responsible for receiving, logging, and tracking the samples for the laboratory must have at least three months experience. This requirement is necessary because of the large number of samples and complexity of the project.

The laboratory shall have in place an acceptable quality assurance (QA) plan. The plan shall designate key QA individuals by name and shall define their responsibilities. The plan shall detail the mechanisms for checking whether laboratory procedures are within control, and shall detail the corrective actions and responsibilities for out-of-control conditions.

### 3.2 SUBCONTRACTING

Subcontracting portions of this work by the subcontracted main lab is acceptable for special analysis, but, subcontracting must be approved by both the MDSL Project Officer and the Pioneer Field Project Officer. All labs involved in this project must abide by the LAP and the QAPjP (Pioneer, 1993b).

### 3.3 CONFIDENTIALITY

Analytical results are to be held in the strictest of confidence and will be discussed with only those individuals approved by the MDSL Project Officer.

### 3.4 REPORTING TIMES

Analytical results are to be reported within 30 working days of sample receipt by the lab. If at all possible, holding/analysis/reporting times should be minimized.



### 3.5 REPORTING FORMAT

#### 3.5.1 TAL Metals

The data report package for the TAL metals will not initially include a standard EPA Contract Lab Program (CLP) package, but the lab must save all the run data on magnetic media in order to generate a CLP package on request for a period of two years following completion of the analysis.

The immediate data deliverable will include the following.

##### 3.5.1.1 General

1. Cover letter documenting analytical protocols used.
2. Copies of completed chain-of-custody forms.
3. Cross-reference table of contractor and lab ID numbers.
4. Data summary tables (hard copy and magnetic media in format to be negotiated between Pioneer and the lab).
5. QA/Quality Control (QC) Summaries including Laboratory Control Samples (LCS), spikes, duplicates, and preparation blank results.

#### 3.5.2 Specialized Data

The specialized analysis (lime requirement components, asbestos, particle size analysis, and CEC) requires components 1 through 5 of Section 3.5.1.1 above.

### 3.6 REPORT TRANSMITTAL

All reports are to be sent directly to Pioneer Technical Services, Inc., 250 Valley View Lane, Butte, Montana in care of Mr. Bill Bullock, Field Project Manager.

## 4.0 QUALITY ASSURANCE REQUIREMENTS

The mechanism used to monitor the precision and accuracy of environmental data is the analysis of field and laboratory QC samples. The required field QC types and frequency are provided in the QAPjP for the Abandoned Mines Hazardous Materials Inventory (Pioneer, 1993b). The required lab QC requirements are specified in the LAP when the CLP SOW for inorganics (EPA, 1990) or the analytical method does not define the QC requirement. Lab QC requirements includes method blanks, duplicates, matrix spikes and lab control samples. These QC requirements are to be performed 1 per 20 samples except for asbestos, particle size analysis, components of the lime requirement, and CEC; the latter analyses



only have duplicates performed. The ranges for precision (duplicates) and accuracy (matrix spikes) acceptability are presented in the QAPjP (Pioneer, 1993b). The method blank should have a reported value within the method detection limit of the IDL.

Calibration procedures and sample preparation procedures are presented in the analytical methods in Appendix A when appropriate. There will be no referee lab or auditing of the main lab or the specialized lab (if applicable) for this project.

## **5.0 ANALYTICAL METHODS**

Analytical methods have been listed in Table 1 and are contained in Appendix A. Any deviations from these methods is unacceptable unless approved by the Field Project Manager, Mr. Bill Bullock and the MDSL Project Officer, Mr. Earl McCurley.

### **5.1 DETECTION LIMITS**

It is the utmost of importance that the instrumentation utilized is sensitive enough to meet the required detection limits. Instruments for target analyte analyses are ICP, AA, and CVAA. Detection limits for the parameters presented in Table 1 are included in the methods in Appendix A.

Historic data indicates metals concentrations will be low (less than 15 percent) at the majority of sites.

### **5.2 STORAGE REQUIREMENTS**

The contracted lab is required to have a secured sample bank for storage of samples, digestates, and extracts. Original samples will be stored in the sample bank for a standard six month interval. All other forms of the sample to be analyzed will be stored in this area for the standard six month interval after analysis or to the end of the analyte holding time, which ever comes first. This provides Pioneer ample time to review data and request reanalysis if necessary. At the end of six months time, the laboratory will be responsible for sample disposal.

### **5.3 CHAIN-OF-CUSTODY**

A sample is physical evidence collected from a facility or from the environment. An essential part of hazardous waste investigations is that samples and data may be used as evidence in legal proceedings.

Laboratories performing analyses will use document control and chain-of-custody procedures as specified in Exhibit F of the CLP SOW for Inorganics (EPA, 1990).

#### 5.4 SAMPLE STREAM

In accordance with EPA procedures, field QC samples (duplicates, blanks, and equipment rinsates) will be treated in the same manner as the natural samples. This provides external QC checks of laboratory data.

#### 6.0 REFERENCES

- American Society for Testing and Materials. 1985. Standard Practice for Particle-Size Analysis and Determination of Soil Constants.
- Pioneer, 1993a. Work Plan for the Abandoned Mines Hazardous Materials Inventory.
- Pioneer, 1993b. Quality Assurance Project Plan for the Abandoned Mines Hazardous Materials Inventory.
- Pioneer, 1993c. Health and Safety Plan for the Abandoned Mines Hazardous Materials Inventory.
- Pioneer, 1993d. Sampling and Analysis Plan for the Abandoned Mines Hazardous Materials Inventory.
- Soil Science Society of America, 1982. Methods of Soil Analysis. Part 2: Chemical and Microbiological Properties.
- U.S. Environmental Protection Agency. 1974. Mine Spoils Potentials for Soil and Water Quality. EPA-670/2-74-070.
- U.S. Environmental Protection Agency. 1978. Field and Laboratory Methods Applicable to Overburden and Minesoils. EPA-600/2-78-054.
- U.S. Environmental Protection Agency, 1984. Methods for Chemical Analysis of Water and Wastes.
- U.S. Environmental Protection Agency, 1986. Test methods for Evaluating Solid Waste - Physical/Chemical Methods, SW-846.
- U.S. Environmental Protection Agency, 1990. Contract Lab Program, Statement of Work. Inorganic Analysis, Multi-Media, Multi-Concentration. March 1990.



**APPENDIX A**  
**ANALYTICAL METHODS**





**TARGET ANALYTE LIST  
CLP SOW INORGANICS**

|                  |   |
|------------------|---|
| <b>EXHIBIT B</b> | <b>REPORTING AND DELIVERABLE REQUIREMENTS</b> |
| <b>EXHIBIT C</b> | <b>TARGET ANALYTE LIST</b>                    |
| <b>EXHIBIT D</b> | <b>ANALYTICAL METHODS</b>                     |
| <b>EXHIBIT E</b> | <b>QA/QC REQUIREMENTS</b>                     |
| <b>EXHIBIT F</b> | <b>CHAIN-OF-CUSTODY</b>                       |



EXHIBIT B

REPORTING AND DELIVERABLES REQUIREMENTS

|   | <u>Page No.</u> |
|---|-----------------|
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| SECTION II: Report Descriptions and Order of Data<br>Deliverables . . . . . | B-4             |
| SECTION III: Form Instruction Guide . . . . .                               | B-13            |
| SECTION IV: Data Reporting Forms . . . . .                                  | B-39            |



## SECTION I

CONTRACT REPORTS/DELIVERABLES DISTRIBUTION  
(For 35-Day Turnaround Contracts)

The following table reiterates the Contract reporting and deliverables requirements specified in the Contract Schedule and specifies the distribution that is required for each deliverable. NOTE: Specific recipient names and addresses are subject to change during the term of the contract. The Administrative Project Officer will notify the Contractor in writing of such changes when they occur.

| Item   | No.<br>Copies | Delivery<br>Schedule  | Distribution |     |     |     |
|--|---------------|---|--------------|-----|-----|-----|
|  |               |   | (1)          | (2) | (3) | (4) |
| *****A. Standard Operating Procedures                      | 3             | 60 days after contract award and as required in Exhibit E.            |              | X   | X   | X   |
| B. Sample Traffic Reports                                  | 1             | 3 days after receipt of last sample in Sample Delivery Group (SDG)*** | X            |     |     |     |
| ***C. Sample Data Package                                  | 2             | 35 days after receipt of last sample in SDG                           | X            |     | X   |     |
| D. Data in Computer Readable Format                        | 1             | 35 days after receipt of last sample in SDG                           | X            |     |     |     |
| ****E. Complete SDG File                                   | 1             | 35 days after receipt of last sample in SDG**                         |              | X   |     |     |
| *F. Quarterly/Annual Verification of Instrument Parameters | 2             | Quarterly: 15th day of January, April, July, October                  | X            |     | X   |     |
| *****G. Quality Assurance Plan                             | 3             | 60 days after contract award and as required in Exhibit E.            | As directed  |     |     |     |

## Distribution:

- (1) Sample Management Office (SMO)
- (2) Region-Client
- (3) Environmental Monitoring Systems Laboratory (EMSL/LV)
- (4) NEIC

## SECTION I

**CONTRACT REPORTS/DELIVERABLES DISTRIBUTION**  
**(For 14-Day Turnaround Contracts)**

The following table reiterates the Contract reporting and deliverables requirements specified in the Contract Schedule and specifies the distribution that is required for each deliverable. NOTE: Specific recipient names and addresses are subject to change during the term of the contract. The Administrative Project Officer will notify the Contractor in writing of such changes when they occur.

| Item   | No.<br>Copies | Delivery<br>Schedule  | Distribution |     |     |     |
|--|---------------|---|--------------|-----|-----|-----|
|  |               |   | (1)          | (2) | (3) | (4) |
| *****A. Standard Operating Procedures                      | 3             | 60 days after contract award and as required in Exhibit E.            |              | X   | X   | X   |
| B. Sample Traffic Reports                                  | 1             | 3 days after receipt of last sample in Sample Delivery Group (SDG)*** | X            |     |     |     |
| ***C. Sample Data Package                                  | 2             | 14 days after receipt of last sample in SDG                           | X            |     | X   |     |
| D. Data in Computer Readable Format                        | 1             | 14 days after receipt of last sample in SDG                           | X            |     |     |     |
| *****E. Complete SDG File                                  | 1             | 14 days after receipt of last sample in SDG**                         |              | X   |     |     |
| *F. Quarterly/Annual Verification of Instrument Parameters | 2             | Quarterly: 15th day of January, April, July, October                  | X            |     | X   |     |
| *****G. Quality Assurance Plan                             | 3             | 60 days after contract award and as required in Exhibit E.            | As directed  |     |     |     |

## Distribution:

- (1) Sample Management Office (SMO)
- (2) Region-Client
- (3) Environmental Monitoring Systems Laboratory (EMSL/LV)
- (4) NEIC

- \* Also required in each Sample Data Package.
- \*\* Concurrent delivery of these items to all recipients is required.
- \*\*\* Sample Delivery Group (SDG) is a group of samples within a Case, received over a period of 14 days or less (seven days or less for 14-day data turnaround contracts) and not exceeding 20 samples. Data for all samples in the SDG are due concurrently. (See SOW Exhibit A, for further description).
- \*\*\*\* Complete SDG file will contain the original sample data package plus all of the original documents described in Exhibit B of the Statement of Work under Complete SDG File.

\*\*\*\*\*See Exhibit E for description

NOTE: As specified in the Contract Schedule (Government Furnished Supplies and Materials), unless otherwise instructed by the CLP Sample Management Office, the Contractor shall dispose of unused sample volume and used sample bottles/containers no earlier than sixty (60) days following submission of analytical data.

Distribution Addresses:

- (1) USEPA Contract Laboratory Program (CLP)  
Sample Management Office (SMO)  
P. O. Box 818  
Alexandria, VA 22313  
For overnight delivery service, use street address:  
300 N. Lee Street  
Alexandria, VA 22313
- (2) USEPA REGIONS: The CLP Sample Management Office, acting on behalf of the Administrative Project Officer, will provide the Contractor with the list of addressees for the ten EPA Regions. SMO will provide the Contractor with updated Regional address/name lists as necessary throughout the period of the contract and identify other client recipients on a case-by-case basis.
- (3) USEPA Environmental Monitoring Systems Laboratory (EMSL/LV)  
944 E. Harmon Avenue  
Las Vegas, NV 89109  
Attn: Data Audit Staff
- (4) USEPA National Enforcement Investigations Center (NEIC)  
Attn: CLP Audit Program  
Denver Federal Center Bldg. 53  
P.O. Box 25227  
Denver, CO 80225



## SECTION II

## REPORT DESCRIPTIONS AND ORDER OF DATA DELIVERABLES

The Contractor laboratory shall provide reports and other deliverables as specified in the Contract Performance/Delivery Schedule (see Contract Schedule, Section F). The required content and form of each deliverable is described in this Exhibit.

All reports and documentation MUST BE as follows:

- o Legible,
- o Clearly labeled and completed in accordance with instructions in this Exhibit,
- o Arranged in increasing alphanumeric EPA sample number order
- o Paginated sequentially according to instructions in this Exhibit, and
- o Single-sided.

If submitted documentation does not conform to the above criteria, the Contractor will be required to resubmit such documentation with deficiency(ies) corrected, at no additional cost to the government.

The Contractor must be prepared to receive the full monthly sample contract requirement at the time of contract award.

Whenever the Contractor is required to submit or resubmit data as a result of an on-site laboratory evaluation or through an Administrative Project Officer (APO)/Technical Project Officer (TPO) action, or through a Regional data reviewer's request, the data must be clearly marked as ADDITIONAL DATA and must be sent to all three contractual data recipients (SMO, EMSL/LV, and Region). A cover letter shall be included which describes what data is being delivered, to which EPA Case(s) the data pertains, and who requested the data.

Whenever the Contractor is required to submit or resubmit data as a result of Contract Compliance Screening (CCS) review by SMO, the data must be sent to all three contractual data recipients (SMO, EMSL/LV and Region), and in all three instances must be accompanied by a color-coded COVER SHEET (Laboratory Response To Results of Contract Compliance Screening) provided by SMO. Diskette deliverables need only be submitted or resubmitted to SMO. Revised DC-1 and DC-2 forms shall be resubmitted to SMO.

Section IV of this Exhibit contains the required Inorganic Analysis Data Reporting Forms in Agency-specified formats; Section III of this Exhibit contains instructions to the Contractor for properly completing all data reporting forms to provide the Agency with all required data. Data elements and field descriptors for reporting data in computer-readable format are contained in Exhibit H.

Descriptions of the requirements for each deliverable item cited in the Contract Performance/Delivery Schedule (see Contract Schedule, Section F) are specified in parts A-G of this Section. Items submitted concurrently must be arranged in the order listed. Additionally, the components of each item must be arranged in the order presented herein when the item is submitted.



A. Quality Assurance Plan and Standard Operating Procedures

See Exhibits E and F for requirements.

B. Sample Traffic Reports

Original Sample Traffic Report page marked "Lab Copy for Return to SMO" with lab receipt information and signed with original Contractor signature, shall be submitted for each sample in the Sample Delivery Group.

Traffic Reports (TRs) shall be submitted in Sample Delivery Group (SDG) sets (i.e., TRs for all samples in an SDG shall be clipped together), with an SDG Cover Sheet attached.

The SDG Cover Sheet shall contain the following items:

- o Lab name
- o Contract number
- o Sample Analysis Price - full sample price from contract.
- o Case Number
- o List of EPA sample numbers of all samples in the SDG, identifying the first and last samples received, and their dates of receipt.

NOTE: When more than one sample is received in the first or last SDG shipment, the "first" sample received would be the sample with the lowest sample number (considering both alpha and numeric designations); the "last" sample received would be the sample with the highest sample number (considering both alpha and numeric designations).

In addition, each Traffic Report must be clearly marked with the SDG Number, the sample number of the first sample in the SDG (as described in the following paragraph). This information should be entered below the Lab Receipt Date on the TR.

EPA field sample numbers are six digits in length. If the Contractor receives sample numbers of any other length, contact SMO immediately. The EPA sample number of the first sample received in the SDG is the SDG number. When several samples are received together in the first SDG shipment, the SDG number shall be the lowest sample number (considering both alpha and numeric designations) in the first group of samples received under the SDG. (The SDG number is also reported on all data reporting forms. See Section III, Form Instruction Guide.)

If samples are received at the laboratory with multi-sample Traffic Reports (TRs), all the samples on one multi-sample TR may not necessarily be in the same SDG. In this instance, the laboratory must make the appropriate number of photocopies of the TR, and submit one copy with each SDG cover sheet.

C. Sample Data Package

The sample data package shall include data for analysis of all samples in one Sample Delivery Group (SDG), including field and analytical samples, reanalyses, blanks, spikes, duplicates, and laboratory control samples.

The sample data package must be complete before submission, must be consecutively paginated (starting with page number one and ending with the number of all pages in the package), and shall include the following:

1. Cover Page for the Inorganic Analyses Data Package, (COVER PAGE -- Inorganic Analyses Data Package), including: laboratory name; laboratory code; contract number; Case No.; Sample Delivery Group (SDG) No.; SAS Number (if appropriate); EPA sample numbers in alphanumeric order showing EPA sample numbers cross-referenced with lab ID numbers; comments, describing in detail any problems encountered in processing the samples in the data package; and, completion of the statement on use of ICP background and interelement corrections for the samples.

The Cover Page shall contain the following statement, verbatim: "I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package and in the computer-readable data submitted on diskette has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature." This statement shall be directly followed by the signature of the Laboratory Manager or his designee with a typed line below it containing the signers name and title, and the date of signature.

In addition, on a separate piece of paper, the Contractor must also include any problems encountered; both technical and administrative, the corrective action taken, and the resolution.

The Contractor shall retain a copy of the Sample Data Package for 365 days after final acceptance of data. After this time, the Contractor may dispose of the package.

## 2. Sample Data

Sample data shall be submitted with the Inorganic Analysis Data Reporting Forms for all samples in the SDG, arranged in increasing alphanumeric EPA sample number order, followed by the QC analyses data, Quarterly Verification of Instrument Parameters forms, raw data, and copies of the digestion and distillation logs.

### a. Results -- Inorganic Analysis Data Sheet [FORM I - IN]

Tabulated analytical results (identification and quantitation) of the specified analytes (Exhibit C). The validation and release of these results is authorized by a specific, signed statement on the Cover Page. If the Laboratory Manager cannot verify all data reported for each sample, he/she must provide a detailed description of the problems associated with the sample(s) on the Cover Page.

Appropriate concentration units must be specified and entered on Form I. The quantitative values shall be reported in units of micrograms per liter (ug/L) for aqueous samples and milligrams per kilogram (mg/kg) for solid samples. No other units are acceptable. Results for solid samples must be reported on a dry weight basis. Analytical results must be reported to two significant figures if the result value is less than 10; to three significant figures if the value is

greater than or equal to 10. Results for percent solids must be reported to one decimal place. The preceding discussion concerning significant numbers applies to Forms I and X only. For other Forms, follow the instructions specific to those forms as contained in this exhibit.

b. Quality Control Data

- 1) Initial and Continuing Calibration Verification [FORM II (PART 1) - IN]
- 2) CRDL Standard for AA and ICP [FORM II (PART 2) - IN]
- 3) Blanks [FORM III - IN]
- 4) ICP Interference Check Sample [FORM IV - IN]
- 5) Spike Sample Recovery [FORM V (PART 1) - IN]
- 6) Post Digest Spike Sample Recovery [FORM V (PART 2) - IN]
- 7) Duplicates [FORM VI - IN]
- 8) Laboratory Control Sample [FORM VII - IN]
- 9) Standard Addition Results [FORM VIII - IN]
- 10) ICP Serial Dilutions [FORM IX - IN]
- 11) Preparation Log [Form XIII - IN]
- 12) Analysis Run Log [Form XIV - IN]

c. Quarterly Verification of Instrument Parameters

- 1) Instrument Detection Limits (Quarterly) [FORM X - IN]
- 2) ICP Interelement Correction Factors (Annually) [FORM XI (PART 1) - IN]
- 3) ICP Interelement Correction Factors (Annually) [FORM XI (PART 2) - IN]
- 4) ICP Linear Ranges (Quarterly) [FORM XII - IN]

(Note that copies of Quarterly Verification of Instrument Parameters forms for the current quarter must be submitted with each data package.)

d. Raw Data

For each reported value, the Contractor shall include in the data package all raw data used to obtain that value. This applies to all required QA/QC measurements, instrument standardization, as well as all sample analysis results. This statement does not apply to the Quarterly Verification of Instrument Parameters submitted as a part



of each data package. Raw data must contain all instrument readouts used for the sample results. Each exposure or instrumental reading must be provided, including those readouts that may fall below the IDL. All AA and ICP instruments must provide a legible hard copy of the direct real-time instrument readout (i.e., stripcharts, printer tapes, etc.). A photocopy of the instruments direct sequential readout must be included. A hardcopy of the instrument's direct instrument readout for cyanide must be included if the instrumentation has the capability.

The order of raw data in the data package shall be: ICP, Flame AA, Furnace AA, Mercury, and Cyanide. All raw data shall include concentration units for ICP and absorbances or concentration units for flame AA, furnace AA, Mercury and Cyanide. All flame and furnace AA data shall be grouped by element.

Raw data must be labeled with EPA sample number and appropriate codes, shown in Table 1 following, to unequivocally identify:

- 1) Calibration standards, including source and prep date.
- 2) Initial and continuing calibration blanks and preparation blanks.
- 3) Initial and continuing calibration verification standards, interference check samples, ICP serial dilution samples, CRDL Standard for ICP and AA, Laboratory Control Sample and post digestion spike.
- 4) Diluted and undiluted samples (by EPA sample number) and all weights, dilutions and volumes used to obtain the reported values. (If the volumes, weights and dilutions are consistent for all samples in a given SDG, a general statement outlining these parameters is sufficient).
- 5) Duplicates.
- 6) Spikes (indicating standard solutions used, final spike concentrations, and volumes involved). If spike information (source, concentration, volume) is consistent for a given SDG, a general statement outlining these parameters is sufficient.
- 7) Instrument used, any instrument adjustments, data corrections or other apparent anomalies on the measurement record, including all data voided or data not used to obtain reported values and a brief written explanation.
- 8) All information for furnace analysis clearly and sequentially identified on the raw data, including EPA sample number, sample and analytical spike data, percent recovery, coefficient of variation, full MSA data, MSA correlation coefficient, slope and intercepts of linear fit, final sample concentration (standard addition concentration), and type of background correction used: BS for Smith-Heiftje, BD for Deuterium Arc, or BZ for Zeeman.



- 9) Time and date of each analysis. Instrument run logs can be submitted if they contain this information. If the instrument does not automatically provide times of analysis, these must be manually entered on all raw data for initial and continuing calibration verification and blanks, as well as interference check samples and the CRDL standard for ICP.

- 10) Integration times for AA analyses.

e. Digestion and Distillation Logs

Logs shall be submitted in the following order: digestion logs for ICP, flame AA, furnace AA and mercury preparations, followed by a copy of the distillation log for cyanide. These logs must include: (1) date, (2) sample weights and volumes, (3) sufficient information to unequivocally identify which QC samples (i.e., laboratory control sample, preparation blank) correspond to each batch digested, (4) comments describing any significant sample changes or reactions which occur during preparation, and (5) indication of pH <2 or >12, as applicable.

f. Properly completed Forms DC-1 and DC-2.

3. A copy of the Sample Traffic Reports submitted in Item A for all of the samples in the SDG. The Traffic Reports shall be arranged in increasing EPA Sample Number order, considering both alpha and numeric designations. A legible photocopy of the SDG cover sheet must also be submitted.

Data in Computer Readable Form

The Contractor shall provide a computer-readable copy of the data on reporting Forms I-XIV for all samples in the Sample Delivery Group, as specified in the Contract Performance/Delivery Schedule. Computer-readable data deliverables shall be submitted on an IBM or IBM-compatible, 5.25 inch floppy double-sided, double density 360 K-byte or a high density 1.2 M-byte diskette or on an IBM or IBM-compatible, 3.5 inch double-sided, double density 720 K-byte or a high density 1.44 M-byte diskette. The data shall be recorded in ASCII, text file format, and shall adhere to the file, record and field specifications listed in Exhibit H, Data Dictionary and Format for Data Deliverables in Computer-Readable Format.

When submitted, diskettes shall be packaged and shipped in such a manner that the diskette(s) cannot be bent or folded, and will not be exposed to extreme heat or cold or any type of electromagnetic radiation. The diskette(s) must be included in the same shipment as the hardcopy data and shall, at a minimum, be enclosed in a diskette mailer.

Table 1  
Codes for Labelling Data

|                                     |                            |
|-------------------------------------|----------------------------|
| Sample                              | XXXXXX                     |
| Sample not part of the SDG          | ZZZZZZ                     |
| Duplicate                           | XXXXXXD                    |
| Matrix Spike                        | XXXXXXS                    |
| Serial Dilution                     | XXXXXXL                    |
| Analytical Spike                    | XXXXXXA                    |
| Post Digestion/Distillation Spike   | XXXXXXA                    |
| MSA:                                |                            |
| Zero Addition                       | XXXXXX0                    |
| First Addition                      | XXXXXX1                    |
| Second Addition                     | XXXXXX2                    |
| Third Addition                      | XXXXXX3                    |
| Instrument Calibration Standards:   |                            |
| ICP                                 | S or S0 for blank standard |
| Atomic Absorption and Cyanide       | S0, S10,...etc.            |
| Initial Calibration Verification    | ICV                        |
| Initial Calibration Blank           | ICB                        |
| Continuing Calibration Verification | CCV                        |
| Continuing Calibration Blank        | CCB                        |
| Interference Check Samples:         |                            |
| Solution A                          | ICSA                       |
| Solution AB                         | ICSAB                      |
| CRDL Standard for AA                | CRA                        |
| CRDL Standard for ICP               | CRI                        |
| Laboratory Control Samples:         |                            |
| Aqueous (Water)                     | LCSW                       |
| Solid (Soil/Sediment)               | LCSS                       |
| Preparation Blank (Water)           | PBW                        |
| Preparation Blank (Soil)            | PBS                        |
| Linear Range Analysis Standard      | LRS                        |

## Notes:

1. When an analytical spike or MSA is performed on samples other than field samples, the "A", "0", "1", "2" or "3" suffixes must be the last to be added to the EPA Sample Number. For instance, an analytical spike of a duplicate must be formatted "XXXXXXDA."
2. The numeric suffix that follows the "S" suffix for the standards indicates the true value of the concentration of the standard in ug/L.
3. ICP calibration standards usually consist of several analytes at different concentrations. Therefore, no numeric suffix can follow the ICP calibration standards unless all the analytes in the standard are prepared at the same concentrations. For instance, the blank for ICP must be formatted "S0."
4. Use suffixes of "0", "1", "2", "3" as appropriate for samples identified with ZZZZZZ on which MSA has been performed to indicate single injections.

E. Results of Intercomparison/Performance Evaluation (PE) Sample Analyses

Tabulation of analytical results for Intercomparison/PE Sample analyses include all requirements specified in items C. and D., above.

F. Complete SDG File (CSF)

As specified in the Delivery Schedule, one Complete SDG File (CSF) including the original Sample Data Package shall be delivered to the Region concurrently with delivery of a copy of the Sample Data Package to SMO and EMSL/LV. The contents of the CSF will be numbered according to the specifications described in Sections III and IV of Exhibit B. The Document Inventory Sheet, Form DC-2, is contained in Section IV. The CSF will contain all original documents where possible. No copies of original documents will be placed in the CSF unless the originals are bound in a logbook maintained by the laboratory. The CSF will contain all original documents specified in Sections III and IV, and Form DC-2 of Exhibit B of the SOW.

The CSF will consist of the following original documents in addition to the documents in the Sample Data Package:

1. Original Sample Data Package
2. A completed and signed Document Inventory Sheet (Form DC-2)
3. All original shipping documents, including, but not limited to, the following documents:
  - a. EPA Chain-of-Custody Record
  - b. Airbills
  - c. EPA (SMO) Traffic Reports
  - d. Sample Tags (if present) sealed in plastic bags.
4. All original receiving documents, including, but not limited to, the following documents:
  - a. Form DC-1
  - b. Other receiving forms or copies of receiving logbooks.
  - c. SDG Cover Sheet
5. All original laboratory records of sample transfer, preparation, and analysis, including, but not limited to, the following documents:
  - a. Original preparation and analysis forms or copies of preparation and analysis logbook pages.
  - b. Internal sample and sample digestate/distillate transfer chain-of-custody records.



5. All other original case-specific documents in the possession of the laboratory, including, but not limited to, the following documents:

- a. Telephone contact logs.
- b. Copies of personal logbook pages.
- c. All handwritten case-specific notes.
- d. Any other case-specific documents not covered by the above.

NOTE: All case-related documentation may be used or admitted as evidence in subsequent legal proceedings. Any other case-specific documents generated after the CSF is sent to EPA, as well as copies that are altered in any fashion, are also deliverables to EPA (original to the Region and copies to SMO and EMSL/LV).

If the laboratory does submit case-specific documents to EPA after submission of the CSF, the documents should be numbered as an addendum to the CSF and a revised DC-2 form should be submitted; or the documents should be numbered as a new CSF and a new DC-2 form should be submitted to the Regions only.

6. Quarterly and Annual Verification of Instrument Parameters

The Contractor shall perform and report quarterly verification of instrument detection limits and linear range by the methods specified in Exhibit E for each instrument used under this contract. For the ICP instrumentation, the Contractor shall also perform and report annual interelement correction factors (including method of determination), wavelengths used and integration times. Forms for Quarterly and Annual Verification of Instrument Parameters for the current quarter and year shall be submitted in each SDG data package, using Forms X, XIA, XIB, and XII. Submission of Quarterly/Annual Verification of Instrument Parameters shall include the raw data used to determine those values reported.

7. Corrective Action Procedures

If a Contractor fails to adhere to the requirements detailed in this SOW, a Contractor may expect, but the Agency is not limited to the following actions: reduction of numbers of samples sent under this contract, suspension of sample shipment to the Contractor, data package audit, an on-site laboratory evaluation, remedial performance evaluation sample, and/or contract sanctions, such as a Cure Notice (see Exhibit E for additional details).



## SECTION III

## FORM INSTRUCTION GUIDE

This section contains specific instructions for the completion of all required Inorganic Data Reporting Forms. This section is organized into the following Parts:

- A. General Information and Header Information
- B. Cover Page -- Inorganic Analyses Data Package [COVER PAGE - IN]
- C. Inorganic Analysis Data Sheet [FORM I - IN]
- D. Initial and Continuing Calibration Verification [FORM II (PART 1) - IN]
- E. CRDL Standard for AA and ICP [FORM II (PART 2) - IN]
- F. Blanks [FORM III - IN]
- G. ICP Interference Check Sample [FORM IV - IN]
- H. Spike Sample Recovery [FORM V (PART 1) - IN]
- I. Post Digest Spike Sample Recovery [FORM V (PART 2) - IN]
- J. Duplicates [FORM VI - IN]
- K. Laboratory Control Sample [FORM VII - IN]
- L. Standard Addition Results [FORM VIII - IN]
- M. ICP Serial Dilutions [FORM IX - IN]
- N. Instrument Detection Limits (Quarterly) [FORM X - IN]
- O. ICP Interelement Correction Factors (Annually) [FORM XI (PART 1) - IN]
- P. ICP Interelement Correction Factors (Annually) [FORM XI (PART 2) - IN]
- Q. ICP Linear Ranges (Quarterly) [FORM XII - IN]
- R. Preparation Log [Form XIII - IN]
- S. Analysis Run Log [Form XIV - IN]
- T. Sample Log-In Sheet [Form DC-1]
- U. Document Inventory Sheet [Form DC-2]

A. General Information and Header Information

The data reporting forms presented in Section IV in this Exhibit have been designed in conjunction with the computer-readable data format specified in Exhibit H, Data Dictionary and Format for Data Deliverables in Computer-Readable Format. The specific length of each variable for computer-readable data transmission purposes is given in Exhibit H. Information entered on these forms must not exceed the size of the field given on the form, including such laboratory-generated items as Lab Name and Lab Sample ID.

Note that on the hardcopy forms (see Section IV), the space provided for entries is greater in some instances than the length prescribed for the variable as written to diskette (see Exhibit H). Greater space is provided on the hardcopy forms for the sake of visual clarity.

Values must be reported on the hardcopy forms according to the individual form instructions in this section. Each form submitted must be filled out completely for all analytes before proceeding to the next form of the same type. Do not submit multiple forms in place of one form if the information on those forms can be submitted on one form.

All characters which appear on the data reporting forms presented in the contract (Exhibit B, Section IV) must be reproduced by the Contractor when submitting data, and the format of the forms submitted must be identical to that shown in the contract. No information may be added, deleted, or moved from its specified position without prior written approval of the EPA Administrative Project Officer. The names of the various fields and analytes (i.e., "Lab Code," "Aluminum") must appear as they do on the forms in the contract, including the options specified in the form (i.e., "Matrix (soil/water):" must appear, not just "Matrix").

All alphabetic entries made onto the forms by the Contractor must be in UPPERCASE letters (i.e., "LOW", not "Low" or "low"). If an entry does not fill the entire blank space provided on the form, null characters must be used to remove the remaining underscores that comprise the blank line. (See Exhibit H for additional instructions.) However, do not remove the underscores or vertical bar characters that delineate "boxes" on the forms.

Six pieces of information are common to the header sections of each data reporting form. These are: Lab Name, Contract, Lab Code, Case No., SAS No., and SDG No. This information must be entered on every form and must match on all forms.

The "Lab Name" must be the name chosen by the Contractor to identify the laboratory. It may not exceed 25 characters.

The "Contract" is the number of the EPA contract under which the analyses were performed.

The "Lab Code" is an alphabetic abbreviation of up to 6 characters, assigned by EPA, to identify the laboratory and aid in data processing. This lab code shall be assigned by EPA at the time a contract is awarded, and must not be modified by the Contractor, except at the direction of EPA.

The "Case No." is the EPA-assigned Case number (to 5 spaces) associated with the sample, and reported on the Traffic Report.

The "SAS No." is the EPA-assigned number for analyses performed under Special Analytical Services. If samples are to be analyzed under SAS only, and reported on these forms, then enter SAS No. and leave Case No. blank. If samples are analyzed according to this SOW (Routine Analytical Services protocol) and have additional SAS requirements, list both Case No. and SAS No. on all forms. If the analyses have no SAS requirements, leave "SAS No." blank. (NOTE: Some samples in an SDG may have a SAS No., while others do not.)

The "SDG No." is the Sample Delivery Group (SDG) number. The SDG number is the EPA Sample Number of the first sample received in the SDG. When several samples are received together in the first SDG shipment, the SDG number must be the lowest sample number (considering both alpha and numeric designations) in the first group of samples received under the SDG.

The other information common to several of the forms is the "EPA Sample No.". This number appears either in the upper righthand corner of the form, or as the left column of a table summarizing data from a number of samples. When "EPA Sample No." is entered into the triple-spaced box in the upper righthand corner of a form, it must be centered on the middle line of the three lines that comprise the box.

All samples, matrix spikes and duplicates must be identified with an EPA Sample Number. For samples, matrix spikes and duplicates, the EPA Sample Number is the unique identifying number given in the Traffic Report that accompanied that sample.

In order to facilitate data assessment, the sample suffixes listed in Table 1 must be used.

Other pieces of information are common to many of the Data Reporting Forms. These include: Matrix and Level.

For "Matrix", enter "SOIL" for soil/sediment samples, and enter "WATER" for water samples. NOTE: The matrix must be spelled out. Abbreviations such as "S" or "W" must not be used.

For "Level", enter the determination of concentration level. Enter as "LOW" or "MED", not "L" or "M".

Note: All results must be transcribed to Forms II-XIV from the raw data to the specified number of decimal places that are described in Exhibits B and H. The raw data result is to be rounded only when the number of figures in the raw data result exceeds the maximum number of figures specified for that result entry for that form. If there are not enough figures in the raw data result to enter in the specified space for that result, then zeros must be used for decimal places to the specified number of reporting decimals for that result for a specific form. The following examples are provided:



| Raw Data Result | Specified Format              | Correct Entry on Form |
|-----------------|-------------------------------|-----------------------|
| 95.99653        | 5.4 (to four decimal places)  | 95.9965               |
| 95.99653        | 5.3 (to three decimal places) | 95.997                |
| 95.99653        | 5.2 (to two decimal places)   | 96.00                 |
| 95.996          | 5.4 (to four decimal places)  | 95.9960               |
| 95.9            | 5.4 (to four decimal places)  | 95.9000               |

For rounding off numbers to the appropriate level of precision, observe the following common rules. If the figure following those to be retained is less than 5, drop it (round down). If the figure is greater than 5, drop it and increase the last digit to be retained by 1 (round up). If the figure following the last digit to be retained equals 5 and there are no digits to the right of the 5 or all digits to the right of the 5 equal zero, then round up if the digit to be retained is odd, or round down if that digit is even. See also Rounding Rules entry in Glossary (Exhibit G).

Before evaluating a number for being in control or out of control of a certain limit, the number evaluated must be rounded using EPA rounding rules to the significance reported for that limit. For instance, the control limit for an ICV is plus or minus 10% of the true value. A reported percent recovery value of 110.4 would be considered in control while a reported value of 110.6 would be considered out of control. In addition, a calculated value of 110.50 would be in control while a calculated value of 110.51 would be out of control.

B. Cover Page - Inorganic Analyses Data Package [COVER PAGE-IN]

This form is used to list all samples analyzed within a Sample Delivery Group, and to provide certain analytical information and general comments. It is also the document which is signed by the Laboratory Manager to authorize and release all data and deliverables associated with the SDG.

Complete the header information according to the instructions in Part A.

For samples analyzed using this SOW, enter " ILM02.0" for SOW No.

Enter the EPA Sample No. (including spikes and duplicates) (to seven spaces) of every sample analyzed within the SDG. Spikes must contain an "S" suffix and duplicates a "D" suffix. These sample numbers must be listed on the form in ascending alphanumeric order. Thus, if MAB123 is the lowest (considering both alpha and numeric characters) EPA Sample No. within the SDG, it would be entered in the first EPA Sample No. field. Samples would be listed below it, in ascending sequence - MAB124, MAB125, MAC111, MA1111, MA1111D, etc.

A maximum of twenty (20) sample numbers can be entered on this form. Submit additional Cover Pages, as appropriate, if the total number of samples, duplicates, and spikes in the SDG is greater than twenty (20).

A Lab Sample ID (to ten spaces) may be entered for each EPA Sample No. If a Lab Sample ID is entered, it must be entered identically (for each EPA Sample No.) on all associated data.



Enter "YES" or "NO" in answer to each of the two questions concerning ICP corrections. Each question must be explicitly answered with a "YES" or a "NO." The third question must be answered with a "YES" or "NO" if the answer to the second question is "YES." It should be left blank if the answer to the second question is "NO."

Under "Comments," enter any statements relevant to the analyses performed under the SDG as a whole.

Each Cover Page must be signed, in original, by the Laboratory Manager or the Manager's designee and dated, to authorize the release and verify the contents of all data and deliverables associated with an SDG.

C. Inorganic Analysis Data Sheet [FORM 1-IN]

This form is used to tabulate and report sample analysis results for target analytes (Exhibit C).

Complete the header information according to the instructions in Part A and as follows.

"Date Received" is the date (formatted MM/DD/YY) of sample receipt at the laboratory, as recorded on the Traffic Report, i.e., the Validated Time of Sample Receipt (VTSR).

"% Solids" is the percent of solids on a weight/weight basis in the sample as determined by drying the sample as specified in Exhibit D. Report percent solids to one decimal place (i.e., 5.3%). If the percent solids is not required because the sample is fully aqueous or less than 1% solids, then enter "0.0."

Enter the appropriate concentration units (UG/L for water or MG/KG dry weight for soil). Entering "MG/KG" means "mg/Kg dry weight" on this form.

Under the column labeled "Concentration," enter for each analyte either the value of the result (if the concentration is greater than or equal to the Instrument Detection Limit) or the Instrument Detection Limit for the analyte corrected for any dilutions (if the concentration is less than the Instrument Detection Limit). The concentration result must be reported to two significant figures if the result is less than 10; to three sig figures if the value is greater than or equal to 10.

Under the columns labeled "C," "Q," and "M," enter result qualifiers as identified below. If additional qualifiers are used, their explicit definitions must be included on the Cover Page in the Comments section.

FORM I-IN includes fields for three types of result qualifiers. These qualifiers must be completed as follows:

- o C (Concentration) qualifier -- Enter "B" if the reported value was obtained from a reading that was less than the Contract Required Detection Limit (CRDL) but greater than or equal to the Instrument Detection Limit (IDL). If the analyte was analyzed for but not detected, a "U" must be entered.

- o Q qualifier -- Specified entries and their meanings are as follows:
  - E - The reported value is estimated because of the presence of interference. An explanatory note must be included under Comments on the Cover Page (if the problem applies to all samples) or on the specific FORM I-IN (if it is an isolated problem).
  - M - Duplicate injection precision not met.
  - N - Spiked sample recovery not within control limits.
  - S - The reported value was determined by the Method of Standard Additions (MSA).
  - W - Post-digestion spike for Furnace AA analysis is out of control limits (85-115%), while sample absorbance is less than 50% of spike absorbance. (See Exhibit E.)
  - \* - Duplicate analysis not within control limits.
  - + - Correlation coefficient for the MSA is less than 0.995.

Entering "S," "W," or "+" is mutually exclusive. No combination of these qualifiers can appear in the same field for an analyte.

- o M (Method) qualifier -- Enter:
  - "P" for ICP
  - "A" for Flame AA
  - "F" for Furnace AA
  - "PM" for ICP when Microwave Digestion is used
  - "AM" for flame AA when Microwave Digestion is used
  - "FM" for Furnace AA when Microwave Digestion is used
  - "CV" for Manual Cold Vapor AA
  - "AV" for Automated Cold Vapor AA
  - "CA" for Midi-Distillation Spectrophotometric
  - "AS" for Semi-Automated Spectrophotometric
  - "C" for Manual Spectrophotometric
  - "T" for Titrimetric
  - " " where no data has been entered
  - "NR" if the analyte is not required to be analyzed.

A brief physical description of the sample, both before and after digestion, must be reported in the fields for color (before and after), clarity (before and after), texture and artifacts. For water samples, report color and clarity. For soil samples, report color, texture and artifacts.

The following descriptive terms are recommended:

- |         |   |  |
|---------|---|--|
| Color   | - | red, blue, yellow, green, orange, violet, white, colorless, brown, grey, black |
| Clarity | - | clear, cloudy, opaque  |
| Texture | - | fine (powdery), medium (sand), coarse (large crystals or rocks)                |

If artifacts are present, enter "YES" in the artifacts field and describe the artifacts in the Comments field. If artifacts are not present, leave this field blank.

Note any significant changes that occur during sample preparation (i.e., emulsion formation) in the Comments field. Enter any sample-specific comments concerning the analyte results in the Comments field.

D. Initial and Continuing Calibration Verification [FORM II(PART 1)-IN]

This form is used to report analyte recoveries from calibration solutions.

Complete the header information according to the instructions in Part A and as follows.

Enter the Initial Calibration Source (12 spaces maximum) and the Continuing Calibration Source (12 spaces maximum). Enter "EPA-LV" or "EPA-CI" to indicate EPA EMSL Las Vegas or Cincinnati, respectively, as the source of EPA standards. When additional EPA supplied solutions are prepared in the future, the Contractor must use the codes supplied with those solutions for identification. If other sources were used, enter sufficient information in the available 12 spaces to identify the manufacturer and the solution used.

Use additional FORMs II(PART 1)-IN if more calibration sources were used.

Under "Initial Calibration True," enter the value (in ug/L, to one decimal place) of the concentration of each analyte in the Initial Calibration Verification Solution.

Under "Initial Calibration Found," enter the most recent value (in ug/L, to two decimal places), of the concentration of each analyte measured in the Initial Calibration Verification Solution.

Under "Initial Calibration %R," enter the value (to one decimal place) of the percent recovery computed according to the following equation:

$$\%R = \frac{\text{Found(ICV)}}{\text{True(ICV)}} \times 100 \quad (2.1)$$

Where, True(ICV) is the true concentration of the analyte in the Initial Calibration Verification Solution and Found(ICV) is the found concentration of the analyte in the Initial Calibration Verification Solution.

The values used in equation 2.1 for True(ICV) and Found(ICV) must be exactly those reported on this form.

Under "Continuing Calibration True," enter the value (in ug/L, to one decimal place) of the concentration of each analyte in the Continuing Calibration Verification Solution.

Under "Continuing Calibration Found," enter the value (in ug/L, to two decimal places) of the concentration of each analyte measured in the Continuing Calibration Verification Solution.



Note that the form contains two "Continuing Calibration Found" columns. The column to the left must contain values for the first Continuing Calibration Verification, and the column to the right must contain values for the second Continuing Calibration Verification. The column to the right should be left blank if no second Continuing Calibration Verification was performed.

If more than one FORM II(PART 1)-IN is required to report multiple Continuing Calibration Verifications, then the column to the left on the second form must contain values for the third Continuing Calibration Verification, the column to the right must contain values for the fourth Continuing Calibration Verification, and so on.

Under "Continuing Calibration %R," enter the value (to one decimal place) of the percent recovery computed according to the following equation:

$$\%R = \frac{\text{Found(CCV)}}{\text{True(CCV)}} \times 100 \quad (2.2)$$

where, True(CCV) is the true concentration of each analyte, and Found(CCV) is the found concentration of the analyte in the Continuing Calibration Verification Solution.

The values used in equation 2.2 for True(CCV) and Found(CCV) must be exactly those reported on this form.

Note that the form contains two "Continuing Calibration %R" columns. Entries to these columns must follow the sequence detailed above for entries to the "Continuing Calibration Found" columns.

Under "M," enter the method used or "NR," as explained in Part C.

If more than one wavelength is used to analyze an analyte, submit additional FORMS II(PART 1)-IN as appropriate.

The order of reporting ICVs and CCVs for each analyte must follow the temporal order in which the standards were run starting with the first Form IIA and moving from the left to the right continuing to the following Form IIA's as appropriate. For instance, the first ICV for all analytes must be reported on the first Form IIA. In a run where three CCVs were analyzed, the first CCV must be reported in the left CCV column on the first Form IIA and the second CCV must be reported in the right column of the same form. The third CCV must be reported in the left CCV column of the second Form IIA. On the second Form IIA, the ICV column and the right CCV column must be left empty in this example. In the previous example, if a second run for an analyte was needed, the ICV of that run must be reported on a third Form IIA and the CCVs follow in the same fashion as explained before. In the case where two wavelengths are used for an analyte, all ICV and CCV results of one wavelength from all runs must be reported before proceeding to report the results of the second wavelength used.



CRDL Standard for AA and ICP [FORM II(PART 2)-IN]

This form is used to report analyte recoveries from analyses of the CRDL Standards for AA (CRA) and 2x the CRDL Standards for ICP (CRI).

Complete the header information according to the instructions in Part A and as follows.

Enter the AA CRDL Standard Source (12 spaces maximum) and the ICP CRDL Standard Source (12 spaces maximum), as explained in Part D.

Under "CRDL Standard for AA True," enter the value (in ug/L, to one decimal place) of the concentration of each analyte in the CRDL Standard Source Solution that was analyzed.

Under "CRDL Standard for AA Found," enter the value (in ug/L, to two decimal places) of the concentration of each analyte measured in the CRDL Standard Solution.

Under "CRDL Standard for AA %R," enter the value (to one decimal place) of the percent recovery computed according to the following equation:

$$\%R = \frac{\text{Found CRDL Standard for AA}}{\text{True CRDL Standard for AA}} \times 100 \quad (2.3)$$

Under "CRDL Standard for ICP Initial True," enter the value (to one decimal place) of the concentration of each analyte in the CRDL Standard Solution that was analyzed by ICP for analytical samples associated with the SDG. Concentration units are ug/L.

Under "CRDL Standard for ICP Initial Found," enter the value (to two decimal places) of the concentration of each analyte measured in the CRDL Standard Solution analyzed at the beginning of each run. Concentration units are ug/L.

Under "CRDL Standard for ICP, Initial %R," enter the value (to one decimal place) of the percent recovery computed according to the following equation:

$$\%R = \frac{\text{CRDL Standard for ICP Initial Found}}{\text{CRDL Standard for ICP True}} \times 100 \quad (2.4)$$

Under "CRDL Standard for ICP Final Found," enter the value (in ug/L, to two decimal places) of the concentration of each analyte measured in the CRDL Standard Solution analyzed at the end of each run.

Under "CRDL Standard for ICP Final %R," enter the value (to one decimal place) of the percent recovery computed according to the following equation:

$$\%R = \frac{\text{CRDL Standard for ICP Final Found}}{\text{CRDL Standard for ICP True}} \times 100 \quad (2.5)$$

All %R values reported in equations 2.3, 2.4, and 2.5 must be calculated using the exact true and found values reported on this form.

Note that for every initial solution reported there must be a final one. However, the opposite is not true. If a CRDL Standard for ICP (CRI) was required to be analyzed in the middle of a run (to avoid exceeding the 8-hour limit), it must be reported in the "Final Found" section of this form.

If more CRI or CRA analyses were required or analyses were performed using more than one wavelength per analyte, submit additional FORMs II(PART 2)-IN as appropriate.

The order of reporting CRAs and CRIs for each analyte must follow the temporal order in which the standards were run starting with the first Form IIB and continuing to the following Form IIBs as appropriate. The order of reporting CRA and CRI is independent with respect to each other. When multiple wavelengths are used for one analyte, all the results of one wavelength must be reported before proceeding to the next wavelength.

F. Blanks [FORM III-IN]

This form is used to report analyte concentrations found in the Initial Calibration Blank (ICB), in Continuing Calibration Blanks (CCB), and in the Preparation Blank (PB).

Complete the header information according to the instructions in Part A and as follows.

Enter "SOIL" or "WATER" as appropriate as the matrix of the Preparation Blank. No abbreviations or other matrix descriptors may be used.

According to the matrix specified for the Preparation Blank, enter "UG/L" (for water) or "MG/KG" (for soil) as the Preparation Blank concentration units.

Under "Initial Calib. Blank," enter the concentration (in ug/L, to one decimal place) of each analyte in the most recent Initial Calibration Blank.

Under the "C" qualifier field, for any analyte enter "B" if the absolute value of the analyte concentration is less than the CRDL but greater than or equal to the IDL. Enter "U" if the absolute value of the analyte in the blank is less than the IDL.

Under "Continuing Calibration Blank 1," enter the concentration (in ug/L, to one decimal place) of each analyte detected in the first required Continuing Calibration Blank (CCB) analyzed after the Initial Calibration Blank. Enter any appropriate qualifier, as explained for the "Initial Calibration Blank," to the "C" qualifier column immediately following the "Continuing Calibration Blank 1" column.

If only one Continuing Calibration Blank was analyzed, then leave the columns labeled "2" and "3" blank. If up to three CCBs were analyzed, complete the columns labeled "2" and "3," in accordance with the instructions for the "Continuing Calibration Blank 1" column. If more than three Continuing Calibration Blanks were analyzed, then complete additional FORMs III-IN as appropriate.

Under "Preparation Blank," enter the concentration in ug/L (to three decimal places) for a water blank or in mg/Kg (to three decimal places) for a soil blank, of each analyte in the Preparation Blank. Enter any appropriate qualifier, as explained for the "Initial Calibration Blank," to the "C" qualifier column immediately following the "Preparation Blank" column.

For all blanks, enter the concentration of each analyte (positive or negative) measured above the IDL or below the negative value of the IDL.

Under "M," enter the method used, as explained in Part C.

If more than one wavelength is used to analyze an analyte, submit additional FORMs III-IN as appropriate.

The order of reporting ICBs and CCBs for each analyte must follow the temporal order in which the blanks were run starting with the first Form III and moving from left to right and continuing to the following Form IIIs as explained in Part D. When multiple wavelengths are used for the analysis of one analyte, all the results of one wavelength must be reported before proceeding to the next wavelength.

G. ICP Interference Check Sample [FORM IV-IN]

This form is used to report Interference Check Sample (ICS) results for each ICP instrument used in Sample Delivery Group analyses.

Complete the header information according to the instructions in Part A and as follows:

For "ICP ID Number," enter an identifier that uniquely identifies a specific instrument within the Contractor laboratory. No two ICP instruments within a laboratory may have the same ICP ID Number.

Enter "ICS Source" (12 spaces maximum) as explained in Part D. For EPA solutions, include in the source name a number identifying it (e.g., EPA-LV87).

Under "True Sol. A," enter the true concentration (in ug/L, to the nearest whole number) of each analyte present in Solution A.

Under "True Sol. AB," enter the true concentration (in ug/L, to the nearest whole number) of each analyte present in Solution AB.

Under "Initial Found Sol. A," enter the concentration (in ug/L, to the nearest whole number) of each analyte found in the initial analysis of Solution A as required in Exhibit E.

Under "Initial Found Sol. AB," enter the concentration (in ug/L, to one decimal place) of each analyte in the initial analysis of Solution AB as required in Exhibit E.

Under "Initial Found %R," enter the value (to one decimal place) of the percent recovery computed for true solution AB greater than zero according to the following equation:



$$\%R = \frac{\text{Initial Found Solution AB}}{\text{True Solution AB}} \times 100 \quad (2.6)$$

Leave the field blank if true solution AB equals zero.

Under "Final Found Sol. A," enter the concentration (in ug/L, to the nearest whole number) of each analyte found in the final analysis of Solution A as required in Exhibit E.

Under "Final Found Sol. AB," enter the concentration (in ug/L, to one decimal place) of each analyte found in the final analysis of Solution AB as required in Exhibit E.

For All Found values of solutions A and AB, enter the concentration (positive, negative, or zero) of each analyte at each wavelength used for analysis by ICP.

Under "Final Found %R," enter the value (to one decimal place) of the percent recovery computed according to the following equation:

$$\%R = \frac{\text{Final Found Solution AB}}{\text{True Solution AB}} \times 100 \quad (2.7)$$

All %R values reported must be calculated using the exact true and found values reported on this form.

Note that for every initial solution reported there must be a final one. However, the opposite is not true. If an ICS was required to be analyzed in the middle of a run (to avoid exceeding the 8-hour limit), it must be reported in the "Final Found" section of this form.

If more ICS analyses were required, submit additional FORMs IV-IN as appropriate.

The order of reporting ICSs for each analyte must follow the temporal order in which the standards were run starting with the first Form IV and continuing to the following Form IVs as appropriate. When multiple wavelengths are used for one analyte, all the results of one wavelength must be reported before proceeding to the next wavelength.

#### H. Spike Sample Recovery [FORM V(PART 1)-IN]

This form is used to report results for the pre-digest spike.

Complete the header information according to the instructions in Part A and as follows.

Indicate the appropriate matrix, level and concentration units (ug/L for water and mg/Kg dry weight for soil) as explained in Parts A and C.

For "%Solids for Sample," enter the percent solids (as explained in Part C) for the original sample of the EPA Sample Number reported on the form. Note that this number must equal the one reported on Form I for that sample.



In the "EPA Sample No." box, enter the EPA Sample Number (7 places maximum) of the sample from which the spike results on this form were obtained. The number must be centered in the box.

Under "Control Limit %R," enter "75-125" if the spike added value was greater than or equal to one-fourth of the sample result value. If not, leave the field empty.

Under "Spiked Sample Result (SSR)," enter the measured value (to four decimal places), in appropriate units, for each relevant analyte in the matrix spike sample. Enter any appropriate qualifier, as explained in Part C, to the "C" qualifier column immediately following the "Spiked Sample Result (SSR)" column.

Under "Sample Result (SR)," enter the measured value (to four decimal places) for each required analyte in the sample (reported in the EPA Sample No. box) on which the matrix spike was performed. Enter any appropriate qualifier, as explained in Part C, to the "C" qualifier column immediately following the "Sample Result (SR)" column.

Under "Spike Added (SA)," enter the value (to two decimal places) for the concentration of each analyte added to the sample. The same concentration units must be used for spiked sample results, unspiked (original sample) results, and spike added sample results. If the "spike added" concentration is specified in the contract, the value added and reported must be that specific concentration in appropriate units, corrected for spiked sample weight and % solids (soils) or spiked sample volume (waters).

Under "%R," enter the value (to one decimal place) of the percent recovery for all spiked analytes computed according to the following equation:

$$\%R = \frac{(SSR - SR)}{SA} \times 100 \quad (2.8)$$

%R must be reported, whether it is negative, positive or zero.

The values for SSR, SR, and SA must be exactly those reported on this form. A value of zero must be used in calculations for SSR or SR if the analyte value is less than the IDL.

Under "Q," enter "N" if the Spike Recovery (%R) is out of the control limits (75-125) and the Spike Added (SA) is greater than or equal to one-fourth of the Sample Result (SR).

Under "M," enter the method used (as explained in Part C) or enter "NR" if the analyte is not required in the spike.

If different samples were used for spike sample analysis of different analytes, additional FORMs V(PART 1)-IN must be submitted for each sample as appropriate.

I. Post Digest Spike Sample Recovery [FORM V(PART 2)-IN]

This form is used to report results for the post-digest spike recovery which is based upon the addition of a known quantity of analyte to an aliquot of the digested sample.

Complete the header information according to the instructions in Part A and as follows.

In the "EPA Sample No." box, enter the EPA Sample Number (7 spaces maximum) of the sample from which the spike results on this form were obtained. The number must be centered in the box.

The "Control Limit %R" and "Q" fields must be left blank until limits are established by EPA. At that time, the Contractor will be informed how to complete these fields.

Under "Spiked Sample Result (SSR)," enter the measured value (in ug/L, to two decimal places) for each analyte in the post-digest spike sample. Enter any appropriate qualifier, as explained in Part C, to the "C" qualifier column immediately following the "Spiked Sample Result (SSR)" column.

Under "Sample Result (SR)," enter the measured value (in ug/L, to two decimal places) for the concentration of each analyte in the sample (reported in the EPA Sample No. box) on which the spike was performed. Enter any appropriate qualifier, as explained in Part C, to the "C" qualifier column immediately following the "Sample Result (SR)" column.

Under "Spike Added (SA)," enter the value (in ug/L, to one decimal place) for each analyte added to the sample. The same concentration units must be used for spiked sample results, unspiked (original sample) results, and spike added sample results. If the spike added concentration is specified in the contract, the value added and reported must be that specific concentration in appropriate units.

Under "%R," enter the value (to one decimal place) of the percent recovery for all spiked analytes computed according to Equation 2.8 in Part H

%R must be reported, whether it is negative, positive or zero.

The values for SSR, SR, and SA must be exactly those reported on this form. A value of zero must be substituted for SSR or SR if the analyte value is less than the IDL.

Under "M," enter the method used as explained in Part C, or enter "NR" if the spike was not required.

If different samples were used for spike sample analysis of different analytes, additional FORMS V(PART 1)-IN must be submitted.

J. Duplicates [FORM VI-IN]

The duplicates form is used to report results of duplicate analyses. Duplicate analyses are required for % solids values and all analyte results.

Complete the header information according to the instructions in Part A and as follows.

Indicate the appropriate matrix, level and concentration units (ug/L for water and mg/Kg dry weight for soil) as explained in Parts A and C.

For "% Solids for Sample," enter the percent solids (as explained in Part C) for the original sample of the EPA Sample Number reported on the form. Note that this number must equal the one reported on Form I for that sample.

For "% Solids for Duplicate," enter the percent solids (as explained in Part C) for the duplicate sample of the EPA Sample Number reported on the form.

In the "EPA Sample No." box, enter the EPA Sample Number (7 spaces maximum) of the sample from which the duplicate sample results on this form were obtained. The number must be centered in the box.

Under "Control Limit," enter the CRDL (in appropriate units, ug/L for water or mg/kg dry weight basis compared to the original sample weight and percent solids) for the analyte if the sample or duplicate values were less than 5x CRDL and greater than or equal to the CRDL. If the sample and duplicate values were greater than or equal to 5x CRDL, leave the field empty.

Under Sample (S), enter the original measured value (to four decimal places) for the concentration of each analyte in the sample (reported in the EPA Sample No. box) on which a Duplicate analysis was performed. Concentration units are those specified on the form. Enter any appropriate qualifier, as explained in Part C, to the "C" qualifier column immediately following the "Sample (S)" column.

Under Duplicate (D), enter the measured value (to four decimal places) for each analyte in the Duplicate sample. Concentration units are those specified on the form. Enter any appropriate qualifier, as explained in Part C, to the "C" qualifier column immediately following the "Duplicate (D)" column.

For solid samples, the concentration of the original sample must be computed using the weight and % solids of the original sample. The concentration of the duplicate sample must be computed using the weight of the duplicate sample, but the % solids of the original sample.

Under RPD, enter the absolute value (to one decimal place) of the Relative Percent Difference for all analytes detected above the IDL in either the sample or the duplicate, computed according to the following equation:

$$RPD = \frac{|S - D|}{(S + D)/2} \times 100 \quad (2.9)$$

The values for S and D must be exactly those reported on this form. A value of zero must be substituted for S or D if the analyte concentration is less than the IDL in either one. If the analyte concentration is less than the IDL in both S and D, leave the RPD field empty.

Under "Q," enter "\*" if the duplicate analysis for the analyte is out of control. If both sample and duplicate values are greater than or equal to 5x CRDL, then the RPD must be less than or equal to 20% to be in control. If either sample or duplicate values are less than 5x CRDL, then the absolute difference between the two values must be less than the CRDL to be in control. If both values are below the CRDL, then no control limit is applicable.

Under "M," enter method used as explained in Part C.



K. Laboratory Control Sample [FORM VII-IN]

This form is used to report results for the solid and aqueous Laboratory Control Samples.

Complete the header information according to the instructions in Part A and as follows.

For the Solid LCS Source (12 spaces maximum), enter the appropriate EPA sample number if the EPA provided standard was used. Substitute an appropriate number provided by the EPA for LCS solutions prepared in the future. If other sources were used, identify the source as explained in Part D. For the Aqueous LCS Source, enter the source name (12 spaces maximum) as explained in Part D.

Under "Aqueous True," enter the value (in ug/L, to one decimal place) of the concentration of each analyte in the Aqueous LCS Standard Source.

Under "Aqueous Found," enter the measured concentration (in ug/L, to two decimal places) of each analyte found in the Aqueous LCS solution.

Under "Aqueous %R," enter the value of the percent recovery (to one decimal place) computed according to the following equation:

$$\%R = \frac{\text{Aqueous LCS Found}}{\text{Aqueous LCS True}} \times 100 \quad (2.10)$$

Under "Solid True," enter the value (in mg/Kg, to one decimal place) of the concentration of each analyte in the Solid LCS Source.

Under "Solid Found," enter the measured value (in mg/Kg, to one decimal place) of each analyte found in the Solid LCS solution.

Under "C," enter "B" or "U" or leave empty, to describe the found value of the solid LCS as explained in Part C.

Under "Limits," enter the lower limit (in mg/Kg, to one decimal place) in the left column, and the upper limit (in mg/Kg, to one decimal place) in the right column, for each analyte in the Solid LCS Source solution.

Under "Solid %R," enter the value of the percent recovery (to one decimal place) computed according to the following equation:

$$\%R = \frac{\text{Solid LCS Found}}{\text{Solid LCS True}} \times 100 \quad (2.11)$$

The values for true and found aqueous and solid LCSs used in equations 2.10 and 2.11 must be exactly those reported on this form. If the analyte concentration is less than the IDL, a value of zero must be substituted for the solid LCS found.

Submit additional FORMs VII-IN as appropriate, if more than one aqueous LCS or solid LCS was required.



L. Standard Addition Results [FORM VIII-IN]

This form is used to report the results of samples analyzed using the Method of Standard Additions (MSA) for Furnace AA analysis.

Complete the header information according to the instructions in Part A.

Under "EPA Sample No.," enter the EPA Sample Numbers (7 spaces maximum) of all analytical samples analyzed using the MSA. This includes reruns by MSA (if the first MSA was out of control) as explained in Exhibit E.

Note that only field samples and duplicates may be reported on this form, thus the EPA Sample Number usually has no suffix or a "D."

A maximum of 32 samples can be entered on this form. If additional samples required MSA, submit additional FORMs VIII-IN. Samples must be listed in alphanumeric order per analyte, continuing to the next FORM VIII-IN if applicable.

Under "An," enter the chemical symbol (2 spaces maximum) for each analyte for which MSA was required for each sample listed. The analytes must be in alphabetic listing of the chemical symbols.

Results for different samples for each analyte must be reported sequentially, with the analytes ordered according to the alphabetic listing of their chemical symbols. For instance, results for As (arsenic) in samples MAA110, MAA111, and MAA112 would be reported in sequence, followed by the result for Pb (lead) in MAA110 etc.

Under "0 ADD ABS," enter the measured value in absorbance units (to three decimal places) for the analyte before any addition is performed.

Under "1 ADD CON," enter the final concentration in ug/L (to two decimal places) of the analyte (excluding sample contribution) after the first addition to the sample analyzed by MSA.

Under "1 ADD ABS," enter the measured value (in the same units and decimal places as "0 ADD ABS") of the sample solution spiked with the first addition.

Under "2 ADD CON," enter the final concentration in ug/L (to two decimal places) of the analyte (excluding sample contribution) after the second addition to the sample analyzed by MSA.

Under "2 ADD ABS," enter the measured value (in the same units and decimal places as "0 ADD ABS") of the sample solution spiked with the second addition.

Under "3 ADD CON," enter the final concentration in ug/L (to two decimal places) of the analyte (excluding sample contribution) after the third addition to the sample analyzed by MSA.

Under "3 ADD ABS," enter the measured value (in the same units and decimal places as "0 ADD ABS") of the sample solution spiked with the third addition.

Note that "0 ADD ABS," "1 ADD ABS" "2 ADD ABS," and "3 ADD ABS" must have the same dilution factor.

Under "Final Conc.," enter the final analyte concentration (in ug/L, to one decimal place) in the sample as determined by MSA computed according to the following formula:

$$\text{Final Conc.} = -(\text{x-intercept}) \quad (2.12)$$

Note that the final concentration of an analyte does not have to equal the value for that analyte which is reported on FORM I-IN for that sample.

Under "r," enter the correlation coefficient (to four decimal places) that is obtained for the least squares regression line representing the following points (x,y):(0.0, "0 ADD ABS"), ("1 ADD CON," "1 ADD ABS"), ("2 ADD CON," "2 ADD ABS"), ("3 ADD CON," "3 ADD ABS").

Note that the correlation coefficient must be calculated using the ordinary least squares linear regression (unweighted) according to the following formula:

$$r = \frac{N \sum x_i y_i - \sum x_i \sum y_i}{[N \sum x_i^2 - (\sum x_i)^2]^{1/2} [N \sum y_i^2 - (\sum y_i)^2]^{1/2}} \quad (2.13)$$

Under "Q," enter "+" if r is less than 0.995. If r is greater than or equal to 0.995, then leave the field empty.

#### M. ICP Serial Dilutions [FORM IX-IN]

This form is used to report results for ICP serial dilution.

Complete the header information according to the instructions in Part A and as follows.

In the "EPA Sample No." box, enter the EPA Sample Number (7 places maximum) of the sample for which serial dilution analysis results on this form were obtained. The number must be centered in the box.

Under "Initial Sample Result (I)," enter the measured value (in ug/L, to two decimal places) for each ICP analyte in the undiluted sample (for the EPA sample number reported on this form). Enter any appropriate qualifier, as explained in Part C, to the "C" qualifier column immediately following the "Initial Sample Result (I)" column.

Note that the Initial Sample Concentration for an analyte does not have to equal the value for that analyte reported on FORM I-IN for that sample. It is the value of the analyte concentration (uncorrected for dilution) that is within the linear range of the instrument.

Under "Serial Dilution Result (S)", enter the measured concentration value (in ug/L, to two decimal places) for each ICP analyte in the diluted sample. The value must be adjusted for that dilution. Enter any appropriate qualifier, as explained in Part B, to the "C" qualifier column immediately following the "Serial Dilution Result (S)" column.

Note that the Serial Dilution Result (S) is obtained by multiplying by five the instrument measured value (in ug/L) of the serially diluted sample and that the "C" qualifier for the serial dilution must be established based on the serial dilution result before correcting it for the dilution regardless of the value reported on the form.

Under "% Difference," enter the absolute value (to one decimal place) of the percent difference in concentration of required analytes, between the original sample and the diluted sample (adjusted for dilution) according to the following formula:

$$\% \text{ Difference} = \frac{|I - S|}{I} \times 100 \quad (2.14)$$

The values for I and S used to calculate % Difference in equation 2.14 must be exactly those reported on this form. A value of zero must be substituted for S if the analyte concentration is less than the IDL. If the analyte concentration in (I) is less than the IDL, concentration leave "% Difference" field empty.

Under "Q," enter "E" if the % Difference is greater than 10% and the original sample concentration (reported on FORM I-IN) is greater than 50x the IDL reported on FORM X-IN.

Under "M," enter the method of analysis for each analyte as explained in Part C.

#### N. Instrument Detection Limits (Quarterly) [FORM X-IN]

This form documents the Instrument Detection Limits for each instrument that the laboratory used to obtain data for the Sample Delivery Group. Only the instrument and wavelengths used to generate data for the SDG must be included.

Although the Instrument Detection Limits (IDLs) are determined quarterly (every three calendar months) a copy of the quarterly instrument detection limits must be included with each SDG data package on FORM(s) X-IN.

Complete the header information according to the instructions in Part A and as follows.

Enter the date (formatted MM/DD/YY) on which the IDL values were obtained (or became effective).

Enter ICP ID Number, Flame AA ID Number, and Furnace AA ID Number (12 spaces maximum each). These ID Numbers are used to uniquely identify each instrument that the laboratory uses to do CLP work.

Enter the Mercury instrument ID number in the Flame AA ID Number field.



Under "Wavelength," enter the wavelength in nanometers (to two decimal places) for each analyte for which an Instrument Detection Limit (IDL) has been established and is listed in the IDL column. If more than one wavelength is used for an analyte, use other FORMs X-IN as appropriate to report the Instrument Detection Limit.

Under "Background," enter the type of background correction used to obtain Furnace AA data. Enter "BS" for Smith Hieftje, "BD" for Deuterium Arc, or "BZ" for Zeeman background correction.

Contract Required Detection Limits (in ug/L) as established in Exhibit C, must appear in the column headed "CRDL."

Under "IDL," enter the Instrument Detection Limit (ug/L, to one decimal place) as determined by the laboratory for each analyte analyzed by the instrument for which the ID Number is listed on this form. The IDL results must be reported to two significant figures if the result value is less than 10, and to three significant figures if the value is greater than or equal to 10. When calculating IDL values, always round up to the appropriate significant figure. This deviation from the EPA rounding rule is necessary to prevent the reporting of detected values for results that fall in the noise region of the calibration curve.

Under "M," enter the method of analysis used to determine the instrument detection limit for each wavelength used. Use appropriate codes as explained in Part C.

Use additional FORMs X-IN if more instruments and wavelengths are used. Note that the date on this form must not exceed the analysis dates in the SDG data package or precede them by more than three months.

Use the Comments section to indicate alternative wavelengths and the conditions under which they are used.

0. ICP Interelement Correction Factors (Annually) [FORM XI(PART 1)-IN]

This form documents for each ICP instrument the interelement correction factors applied by the Contractor laboratory to obtain data for the Sample Delivery Group.

Although the correction factors are determined annually (every twelve calendar months), a copy of the results of the annual interelement correction factors must be included with each SDG data package on FORM XI(PART 1)-IN.

Complete the header information according to instructions in Part A and as follows.

Enter the ICP ID Number (12 spaces maximum), which is a unique number designated by the laboratory to identify each ICP instrument used to produce data in the SDG package. If more than one ICP instrument is used, submit additional FORMs XI(PART 1)-IN as appropriate.



Report the date (formatted as MM/DD/YY) on which these correction factors were determined for use. This date must not exceed the ICP analysis dates in the SDG data package or precede them by more than twelve calendar months.

Under "Wavelength," list the wavelength in nanometers (to two decimal places) used for each ICP analyte. If more than one wavelength is used, submit additional FORMs XI(PART 1)-IN as appropriate.

Under "Al," "Ca," "Fe," "Mg, enter the correction factor (negative, positive or zero, to seven decimal places, 10 spaces maximum) for each ICP analyte. If correction factors for another analyte are applied, use the empty column and list the analyte's chemical symbol in the blank two-space header field provided for that column.

If corrections are not applied for an analyte, a zero must be entered for that analyte to indicate that the corrections were determined to be zero. If correction factors are applied for more than one additional analyte, use FORM XI(PART 2)-IN.

P. ICP Interelement Correction Factors (Annually) [FORM XI(PART 2)-IN]

This form is used if correction factors for analytes other than Al, Ca, Fe, Mg, and one more analyte of the Contractor's choice, were applied to the analytes analyzed by ICP. Complete this form as for FORM XI(PART 1)-IN by listing the chemical symbol for additional analytes in the heading of the empty columns in the two-space fields provided.

Columns of correction factors for additional analytes must be entered left to right starting on FORM XI(PART 1)-IN and proceeding to FORM XI(PART 2)-IN, according to the alphabetic order of their chemical symbols. Note that correction factors for Al, Ca, Fe, and Mg are all required and are to be listed first (as they appear on FORM XI(PART 1)-IN).

Q. ICP Linear Ranges (Quarterly) [FORM XII-IN]

This form documents the quarterly linear range analysis for each ICP instrument that the laboratory used to obtain data for the SDG.

Complete the header information according to the instructions in Part A and as follows.

Enter the ICP ID Number (12 spaces maximum), which is a unique number designated by the Contractor to identify each ICP instrument used to produce data for the SDG. If more than one ICP instrument is used, submit additional FORMs XII-IN as appropriate.

Report the date (formatted as MM/DD/YY) on which these linear ranges were determined for use. This date must not exceed the dates of analysis by ICP in the SDG data package and must not precede the analysis dates by more than three calendar months.

Under "Integ. Time (Sec.)," enter the integration time (in seconds to two decimal places) used for each measurement taken from the ICP instrument.

Under "Concentration," enter the concentration (in ug/L) that is the upper limit of the ICP instrument linear range as determined in Exhibit E. Any measurement in the SDG data package at or below this concentration is within the linear range. Any measurement above it is out of the linear range, and thus, is an estimated value and must be diluted into the linear range.

Under "M," enter the method of analysis for each analyte as explained in Part C.

If more instruments or analyte wavelengths are used, submit additional FORMs XII-IN as appropriate.

R. Preparation Log [Form XIII-IN]

This Form is used to report the preparation run log.

All field samples and all quality control preparations (including duplicates, matrix spikes, LCSs, PBs and repreparations) associated with the SDG must be reported on Form XIII.

Submit one Form XIII per batch, per method, if no more than thirty-two preparations, including quality control preparations, were performed. If more than thirty-two preparations per batch, per method, were performed, then submit additional copies of Form XIII as appropriate. Submit a separate Form XIII for each batch.

The order in which the Preparation Logs are submitted is very important. Form XIII must be organized by method, by batch. Later batches within a method must follow earlier ones. Each batch must start on a separate Form XIII.

Complete the header information according to the instructions in Part A, and as follows:

For "Method," enter the method of analysis (two characters maximum) for which the preparations listed on the Form were made. Use appropriate method codes as specified in Part C.

Under "EPA Sample No.," enter the EPA Sample Number of each sample in the SDG, and of all other preparations such as duplicates, matrix spikes, LCSs, PBs, and repreparations (all formatted according to Table 1). All EPA Sample Numbers must be listed in ascending alphanumeric order, continuing to the next Form XIII if applicable.

Under "Preparation Date," enter the date (formatted MM/DD/YY) on which each sample was prepared for analysis by the method indicated in the header section of the Form.

Note that the date never changes on a single Form XIII because the form must be submitted per batch.

Under "Weight," enter the wet weight (in grams, to two decimal places) of each soil sample prepared for analysis by the method indicated in the header section of the Form. If the sample matrix is water, then leave the field empty.

Under "Volume," enter the final volume (in mL, to the nearest whole number) the preparation for each sample prepared for analysis by the method indicated in the header section of the Form. This field must have a value for each sample listed.

S. Analysis Run Log [Form XIV-IN]

This Form is used to report the sample analysis run log.

A run is defined as the totality of analyses performed by an instrument throughout the sequence initiated by, and including, the first SOW-required calibration standard and terminated by, and including, the continuing calibration verification and blank following the last SOW-required analytical sample.

All field samples and all quality control analyses (including calibration standards, ICVs, CCVs, ICBs, CCBs, CRAs, CRIs, ICSs, LRSs, LCSs, PBs, duplicates, serial dilutions, pre-digestion spikes, post-digestion spikes, analytical spikes, and each addition analyzed for the method of standard addition determination) associated with the SDG must be reported on Form XIV. The run must be continuous and inclusive of all analyses performed on the particular instrument during the run.

Submit one Form XIV per run if no more than thirty-two (32) analyses, including instrument calibration, were analyzed in the run. If more than thirty-two analyses were performed in the run, submit additional Forms XIV as appropriate.

The order in which the Analysis Run Logs are submitted is very important. Form XIV must be organized by method, by run. Later runs within a method must follow earlier ones. Each analytical run must start on a separate Form XIV. Therefore, instrument calibration must be the first entry on the form for each new run. In addition, the run is considered to have ended if it is interrupted for any reason, including termination for failing QC parameters.

Complete the header information according to the instructions in Part A, and as follows:

For "Instrument ID Number," enter the instrument ID number, (12 spaces maximum), which must be an identifier designated by the laboratory to uniquely identify each instrument used to produce data which are required to be reported in the SDG deliverable. If more than one instrument is used, submit additional Forms XIV as appropriate.

For "Method," enter the method code (two characters maximum) according to the specifications in Part C.

For "Start Date," enter the date (formatted MM/DD/YY) on which the analysis run was started.

For "End Date," Enter the date (formatted MM/DD/YY) on which the analysis run was ended.



Under "EPA Sample No.," enter the EPA sample number of each analysis, including all QC operations applicable to the SDG (formatted according to Table 1). All EPA Sample Numbers must be listed in increasing temporal (date and time) order of analysis, continuing to the next Form XIV for the instrument run if applicable. The analysis date and time of other analyses not associated with the SDG, but analyzed by the instrument in the reported analytical run, must be reported. Those analyses must be identified with the EPA Sample No. of "ZZZZZZ."

Under "D/F," enter the dilution factor (to two decimal places) by which the final digestate or distillate needed to be diluted for each analysis to be performed. The dilution factor does not include the dilution inherent in the preparation as specified by the preparation procedures in Exhibit D.

The dilution factor is required for all entries on Form XIV.

Note that for a particular sample a dilution factor of "1" must be entered if the digestate or distillate were analyzed without adding any further volume of dilutant or any other solutions to the "Volume" or an aliquot of the "Volume" listed on Form XIII for that sample.

For EPA supplied solutions such as ICVs, ICSs, and LCSs, a dilution factor must be entered if the supplied solution had to be diluted to a dilution different from that specified by the instructions provided with the solution. The dilution factor reported in such a case must be that which would make the reported true values on the appropriate form for the solution equal those that were supplied with the solution by the EPA. For instance, ICV-2(0887) has a true value of 104.0 ug/L at a 20 fold dilution. If the solution is prepared at a 40 fold dilution, a dilution factor of "2" must be entered on Form XIV and the uncorrected instrument reading is compared to a true value of 52 ug/L. In this example, Form II will have a true value of 104.0 regardless of the dilution used. The found value for the ICV must be corrected for the dilution listed on Form XIV using the following formula:

Found value on Form II = Instrument readout in ug/L x D/F

Under "Time," enter the time, (in military format - HHMM), at which each analysis was performed. If an auto sampler is used with equal analysis time and intervals between analyses, then only the start time of the run (the time of analysis of the first calibration standard) and end time of the run (the time of analysis of the final CCV or CCB, whichever is later) need to be reported.

Under "% R," enter the percent recovery (to one decimal place) for each Furnace AA analytical spike analyzed. If the analytical spike was performed on more than one analyte, use additional Forms XIV as appropriate. Leave the "% R" field empty if the analysis reported is not for an analytical spike. %R must be recorded even if the result is not used.

A %R value of "-9999.9" must be entered for the analytical spike if either the sample or analytical results is greater than the calibration range of the instrument.



Under "Analytes," enter "X" in the column of the designated analyte to indicate that the analyte value was used from the reported analysis to report data in the SDG. Leave the column empty for each analyte if the analysis was not used to report the particular analyte.

Entering "X" appropriately is very important. The "X" is used to link the samples with their related QC. It also links the dilution factor with the appropriate result reported on Forms I-IX. For each analyte result reported on any of the Forms I-IX, there must be one, and only one, properly identified entry on Form XIV for which an "X" is entered in the column for that analyte.

T. Sample Log-In Sheet [Form DC-1]

This form is used to document the receipt and inspection of samples and containers. One original of Form DC-1 is required for each sample shipping container, e.g., cooler. If the samples in a single sample shipping container must be assigned to more than one Sample Delivery Group, the original Form DC-1 shall be placed with the deliverables for the Sample Delivery Group of the lowest Arabic number and a copy of Form DC-1 must be placed with the deliverables for the other Sample Delivery Group(s). The copies should be identified as "copy(ies)," and the location of the original should be noted on the copies.

Sign and date the airbill (if present). Examine the shipping container and record the presence/absence of custody seals and their condition (i.e., intact, broken) in item 1 on Form DC-1. Record the custody seal numbers in item 2.

Open the container, remove the enclosed sample documentation, and record the presence/absence of chain-of-custody record(s), SMO forms (i.e., Traffic Reports, Packing Lists), and airbills or airbill stickers in items 3-5 on Form DC-1. Specify if there is an airbill present or an airbill sticker in item 5 on Form DC-1. Record the airbill or sticker number in item 6.

Remove the samples from the shipping container(s), examine the samples and the sample tags (if present), and record the condition of the sample bottles (i.e., intact, broken, leaking) and presence or absence of sample tags in items 7 and 8 on Form DC-1.

Review the sample shipping documents and complete the header information described in Part A. Compare the information recorded on all the documents and samples and mark the appropriate answer in item 9 on Form DC-1.

If there are no problems observed during receipt, sign and date (include time) Form DC-1, the chain-of-custody record, and Traffic Report, and write the sample numbers on Form DC-1. Record the appropriate sample tags and assigned laboratory numbers if applicable. The log-in date should be recorded at the top of Form DC-1 and the date and time of cooler receipt at the laboratory should be recorded in items 10 and 11. Cross out unused columns and spaces.

If there are problems observed during receipt, contact SMO and document the contact as well as resolution of the problem on a CLP Communication Log. Following resolution, sign and date the forms as specified in the preceding paragraph and note, where appropriate, the resolution of the problem.

Record the fraction designation (if appropriate) and the specific area designation (e.g., refrigerator number) in the Sample Transfer block located in the bottom left corner of Form DC-1. Sign and date the sample transfer block.

U. Document Inventory Sheet (Form DC-2)

This form is used to record the inventory of the Complete SDG File (CSF) documents which are sent to the Region.

Organize all EPA-CSF documents as described in Exhibit B, Section II and Section III. Assemble the documents in the order specified on Form DC-2 and Sections II and III, and stamp each page with the consecutive number. (Do not number the DC-2 form). Inventory the CSF by reviewing the document numbers and recording page numbers ranges in the column provided on the Form DC-2. If there are no documents for a specific document type, enter an "NA" in the empty space.

Certain laboratory specific documents related to the CSF may not fit into a clearly defined category. The laboratory should review DC-2 to determine if it is most appropriate to place them under No. 29, 30, 31, or 32. Category 32 should be used if there is no appropriate previous category. These types of documents should be described or listed in the blanks under each appropriate category.



## COVER PAGE - INORGANIC ANALYSES DATA PACKAGE

Lab Name: \_\_\_\_\_ Contract: \_\_\_\_\_  
Lab Code: \_\_\_\_\_ Case No.: \_\_\_\_\_ SAS No.: \_\_\_\_\_ SDG No.: \_\_\_\_\_  
SOW No.: \_\_\_\_\_

Lab Sample ID.

[illegible][illegible]

Yes/No

Yes/No

Yes/No

**Comments:**

[illegible]

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package and in the computer-readable data submitted on diskette has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature.

Signature: \_\_\_\_\_ Name: \_\_\_\_\_  
Date: \_\_\_\_\_ Title: \_\_\_\_\_



## U.S. EPA - CLP

1  
INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE 1

Lab Name: \_\_\_\_\_ Contract: \_\_\_\_\_

Lab Code: \_\_\_\_\_ Case No.: \_\_\_\_\_ SAS No.: \_\_\_\_\_ SDG No.: \_\_\_\_\_

Matrix (soil/water): \_\_\_\_\_ Lab Sample ID: \_\_\_\_\_

Level (low/med): \_\_\_\_\_ Date Received: \_\_\_\_\_

% Solids: \_\_\_\_\_

Concentration Units (ug/L or mg/kg dry weight): \_\_\_\_\_

| CAS No.   | Analyte   | Concentration | C | Q | M |
|-----------|-----------|---------------|---|---|---|
| 7429-90-5 | Aluminum  |               |   |   |   |
| 7440-36-0 | Antimony  |               |   |   |   |
| 7440-38-2 | Arsenic   |               |   |   |   |
| 7440-39-3 | Barium    |               |   |   |   |
| 7440-41-7 | Beryllium |               |   |   |   |
| 7440-43-9 | Cadmium   |               |   |   |   |
| 7440-70-2 | Calcium   |               |   |   |   |
| 7440-47-3 | Chromium  |               |   |   |   |
| 7440-48-4 | Cobalt    |               |   |   |   |
| 7440-50-8 | Copper    |               |   |   |   |
| 7439-89-6 | Iron      |               |   |   |   |
| 7439-92-1 | Lead      |               |   |   |   |
| 7439-95-4 | Magnesium |               |   |   |   |
| 7439-96-5 | Manganese |               |   |   |   |
| 7439-97-6 | Mercury   |               |   |   |   |
| 7440-02-0 | Nickel    |               |   |   |   |
| 7440-09-7 | Potassium |               |   |   |   |
| 7782-49-2 | Selenium  |               |   |   |   |
| 7440-22-4 | Silver    |               |   |   |   |
| 7440-23-5 | Sodium    |               |   |   |   |
| 7440-28-0 | Thallium  |               |   |   |   |
| 7440-62-2 | Vanadium  |               |   |   |   |
| 7440-66-6 | Zinc      |               |   |   |   |
|           | Cyanide   |               |   |   |   |

Color Before: \_\_\_\_\_ Clarity Before: \_\_\_\_\_ Texture: \_\_\_\_\_

Color After: \_\_\_\_\_ Clarity After: \_\_\_\_\_ Artifacts: \_\_\_\_\_

Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

U.S. EPA - CLP

2A

INITIAL AND CONTINUING CALIBRATION VERIFICATION

Lab Name: \_\_\_\_\_ Contract: \_\_\_\_\_  
 Lab Code: \_\_\_\_\_ Case No.: \_\_\_\_\_ SAS No.: \_\_\_\_\_ SDG No.: \_\_\_\_\_  
 Initial Calibration Source: \_\_\_\_\_  
 Continuing Calibration Source: \_\_\_\_\_

Concentration Units: ug/L

| Analyte   | Initial Calibration |       |       | Continuing Calibration |       |       |       |       | M |
|-----------|---------------------|-------|-------|------------------------|-------|-------|-------|-------|---|
|           | True                | Found | %R(1) | True                   | Found | %R(1) | Found | %R(1) |   |
| Aluminum  |                     |       |       |                        |       |       |       |       |   |
| Antimony  |                     |       |       |                        |       |       |       |       |   |
| Arsenic   |                     |       |       |                        |       |       |       |       |   |
| Barium    |                     |       |       |                        |       |       |       |       |   |
| Beryllium |                     |       |       |                        |       |       |       |       |   |
| Cadmium   |                     |       |       |                        |       |       |       |       |   |
| Calcium   |                     |       |       |                        |       |       |       |       |   |
| Chromium  |                     |       |       |                        |       |       |       |       |   |
| Cobalt    |                     |       |       |                        |       |       |       |       |   |
| Copper    |                     |       |       |                        |       |       |       |       |   |
| Iron      |                     |       |       |                        |       |       |       |       |   |
| Lead      |                     |       |       |                        |       |       |       |       |   |
| Magnesium |                     |       |       |                        |       |       |       |       |   |
| Manganese |                     |       |       |                        |       |       |       |       |   |
| Mercury   |                     |       |       |                        |       |       |       |       |   |
| Nickel    |                     |       |       |                        |       |       |       |       |   |
| Potassium |                     |       |       |                        |       |       |       |       |   |
| Selenium  |                     |       |       |                        |       |       |       |       |   |
| Silver    |                     |       |       |                        |       |       |       |       |   |
| Sodium    |                     |       |       |                        |       |       |       |       |   |
| Thallium  |                     |       |       |                        |       |       |       |       |   |
| Vanadium  |                     |       |       |                        |       |       |       |       |   |
| Zinc      |                     |       |       |                        |       |       |       |       |   |
| Cyanide   |                     |       |       |                        |       |       |       |       |   |

(1) Control Limits: Mercury 80-120; Other Metals 90-110; Cyanide 85-115

## U.S. EPA - CLP

2B

## CRDL STANDARD FOR AA AND ICP

Lab Name: \_\_\_\_\_

Contract: \_\_\_\_\_

Lab Code: \_\_\_\_\_ Case No.: \_\_\_\_\_

SAS No.: \_\_\_\_\_ SDG No.: \_\_\_\_\_

AA CRDL Standard Source: \_\_\_\_\_

ICP CRDL Standard Source: \_\_\_\_\_

Concentration Units: ug/L

| Analyte   | CRDL Standard for AA |       |    | CRDL Standard for ICP |                  |    |                |
|-----------|----------------------|-------|----|-----------------------|------------------|----|----------------|
|           | True                 | Found | %R | True                  | Initial<br>Found | %R | Final<br>Found |
| Aluminum  |                      |       |    |                       |                  |    |                |
| Antimony  |                      |       |    |                       |                  |    |                |
| Arsenic   |                      |       |    |                       |                  |    |                |
| Barium    |                      |       |    |                       |                  |    |                |
| Beryllium |                      |       |    |                       |                  |    |                |
| Cadmium   |                      |       |    |                       |                  |    |                |
| Calcium   |                      |       |    |                       |                  |    |                |
| Chromium  |                      |       |    |                       |                  |    |                |
| Cobalt    |                      |       |    |                       |                  |    |                |
| Copper    |                      |       |    |                       |                  |    |                |
| Iron      |                      |       |    |                       |                  |    |                |
| Lead      |                      |       |    |                       |                  |    |                |
| Magnesium |                      |       |    |                       |                  |    |                |
| Manganese |                      |       |    |                       |                  |    |                |
| Mercury   |                      |       |    |                       |                  |    |                |
| Nickel    |                      |       |    |                       |                  |    |                |
| Potassium |                      |       |    |                       |                  |    |                |
| Selenium  |                      |       |    |                       |                  |    |                |
| Silver    |                      |       |    |                       |                  |    |                |
| Sodium    |                      |       |    |                       |                  |    |                |
| Thallium  |                      |       |    |                       |                  |    |                |
| Vanadium  |                      |       |    |                       |                  |    |                |
| Zinc      |                      |       |    |                       |                  |    |                |

## U.S. EPA - CLP

3  
BLANKS

Lab Name: \_\_\_\_\_ Contract: \_\_\_\_\_

Lab Code: \_\_\_\_\_ Case No.: \_\_\_\_\_ SAS No.: \_\_\_\_\_ SDG No.: \_\_\_\_\_

Preparation Blank Matrix (soil/water): \_\_\_\_\_

Preparation Blank Concentration Units (ug/L or mg/kg): \_\_\_\_\_

| Analyte   | Initial<br>Calib.<br>Blank<br>(ug/L) | C | Continuing Calibration<br>Blank (ug/L) |   |   |   |   |   | Prepa-<br>ration<br>Blank | C | M |
|-----------|--------------------------------------|---|--|---|---|---|---|---|---------------------------|---|---|
|           |                                      |   | 1                                      | C | 2 | C | 3 | C |                           |   |   |
| Aluminum  |                                      |   |  |   |   |   |   |   |                           |   |   |
| Antimony  |                                      |   |  |   |   |   |   |   |                           |   |   |
| Arsenic   |                                      |   |  |   |   |   |   |   |                           |   |   |
| Barium    |                                      |   |  |   |   |   |   |   |                           |   |   |
| Beryllium |                                      |   |  |   |   |   |   |   |                           |   |   |
| Cadmium   |                                      |   |  |   |   |   |   |   |                           |   |   |
| Calcium   |                                      |   |  |   |   |   |   |   |                           |   |   |
| Chromium  |                                      |   |  |   |   |   |   |   |                           |   |   |
| Cobalt    |                                      |   |  |   |   |   |   |   |                           |   |   |
| Copper    |                                      |   |  |   |   |   |   |   |                           |   |   |
| Iron      |                                      |   |  |   |   |   |   |   |                           |   |   |
| Lead      |                                      |   |  |   |   |   |   |   |                           |   |   |
| Magnesium |                                      |   |  |   |   |   |   |   |                           |   |   |
| Manganese |                                      |   |  |   |   |   |   |   |                           |   |   |
| Mercury   |                                      |   |  |   |   |   |   |   |                           |   |   |
| Nickel    |                                      |   |  |   |   |   |   |   |                           |   |   |
| Potassium |                                      |   |  |   |   |   |   |   |                           |   |   |
| Selenium  |                                      |   |  |   |   |   |   |   |                           |   |   |
| Silver    |                                      |   |  |   |   |   |   |   |                           |   |   |
| Sodium    |                                      |   |  |   |   |   |   |   |                           |   |   |
| Thallium  |                                      |   |  |   |   |   |   |   |                           |   |   |
| Vanadium  |                                      |   |  |   |   |   |   |   |                           |   |   |
| Zinc      |                                      |   |  |   |   |   |   |   |                           |   |   |
| Cyanide   |                                      |   |  |   |   |   |   |   |                           |   |   |



U.S. EPA - CLP

4

ICP INTERFERENCE CHECK SAMPLE

Lab Name: \_\_\_\_\_ Contract: \_\_\_\_\_  
 Lab Code: \_\_\_\_\_ Case No.: \_\_\_\_\_ SAS No.: \_\_\_\_\_ SDG No.: \_\_\_\_\_  
 ICP ID Number: \_\_\_\_\_ ICS Source: \_\_\_\_\_

Concentration Units: ug/L

| Analyte   | True   |         | Initial Found |         |    | Final Found |         |    |
|-----------|--------|---------|---------------|---------|----|-------------|---------|----|
|           | Sol. A | Sol. AB | Sol. A        | Sol. AB | %R | Sol. A      | Sol. AB | %R |
| Aluminum  |        |         |               |         |    |             |         |    |
| Antimony  |        |         |               |         |    |             |         |    |
| Arsenic   |        |         |               |         |    |             |         |    |
| Barium    |        |         |               |         |    |             |         |    |
| Beryllium |        |         |               |         |    |             |         |    |
| Cadmium   |        |         |               |         |    |             |         |    |
| Calcium   |        |         |               |         |    |             |         |    |
| Chromium  |        |         |               |         |    |             |         |    |
| Cobalt    |        |         |               |         |    |             |         |    |
| Copper    |        |         |               |         |    |             |         |    |
| Iron      |        |         |               |         |    |             |         |    |
| Lead      |        |         |               |         |    |             |         |    |
| Magnesium |        |         |               |         |    |             |         |    |
| Manganese |        |         |               |         |    |             |         |    |
| Mercury   |        |         |               |         |    |             |         |    |
| Nickel    |        |         |               |         |    |             |         |    |
| Potassium |        |         |               |         |    |             |         |    |
| Selenium  |        |         |               |         |    |             |         |    |
| Silver    |        |         |               |         |    |             |         |    |
| Sodium    |        |         |               |         |    |             |         |    |
| Thallium  |        |         |               |         |    |             |         |    |
| Vanadium  |        |         |               |         |    |             |         |    |
| Zinc      |        |         |               |         |    |             |         |    |

U.S. EPA - CLP

5A  
SPIKE SAMPLE RECOVERY

EPA SAMPLE NO.

Lab Name: \_\_\_\_\_ Contract: \_\_\_\_\_  
 Lab Code: \_\_\_\_\_ Case No.: \_\_\_\_\_ SAS No.: \_\_\_\_\_ SDG No.: \_\_\_\_\_  
 Matrix (soil/water): \_\_\_\_\_ Level (low/med): \_\_\_\_\_  
 % Solids for Sample: \_\_\_\_\_

Concentration Units (ug/L or mg/kg dry weight): \_\_\_\_\_

| Analyte   | Control<br>Limit<br>%R | Spiked Sample<br>Result (SSR) | C | Sample<br>Result (SR) | C | Spike<br>Added (SA) | %R | Q | M |
|-----------|------------------------|-------------------------------|---|-----------------------|---|---------------------|----|---|---|
| Aluminum  |                        |                               |   |                       |   |                     |    |   |   |
| Antimony  |                        |                               |   |                       |   |                     |    |   |   |
| Arsenic   |                        |                               |   |                       |   |                     |    |   |   |
| Barium    |                        |                               |   |                       |   |                     |    |   |   |
| Beryllium |                        |                               |   |                       |   |                     |    |   |   |
| Cadmium   |                        |                               |   |                       |   |                     |    |   |   |
| Calcium   |                        |                               |   |                       |   |                     |    |   |   |
| Chromium  |                        |                               |   |                       |   |                     |    |   |   |
| Cobalt    |                        |                               |   |                       |   |                     |    |   |   |
| Copper    |                        |                               |   |                       |   |                     |    |   |   |
| Iron      |                        |                               |   |                       |   |                     |    |   |   |
| Lead      |                        |                               |   |                       |   |                     |    |   |   |
| Magnesium |                        |                               |   |                       |   |                     |    |   |   |
| Manganese |                        |                               |   |                       |   |                     |    |   |   |
| Mercury   |                        |                               |   |                       |   |                     |    |   |   |
| Nickel    |                        |                               |   |                       |   |                     |    |   |   |
| Potassium |                        |                               |   |                       |   |                     |    |   |   |
| Selenium  |                        |                               |   |                       |   |                     |    |   |   |
| Silver    |                        |                               |   |                       |   |                     |    |   |   |
| Sodium    |                        |                               |   |                       |   |                     |    |   |   |
| Thallium  |                        |                               |   |                       |   |                     |    |   |   |
| Vanadium  |                        |                               |   |                       |   |                     |    |   |   |
| Zinc      |                        |                               |   |                       |   |                     |    |   |   |
| Cyanide   |                        |                               |   |                       |   |                     |    |   |   |

Comments:

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U.S. EPA - CLP

5B  
POST DIGEST SPIKE SAMPLE RECOVERY

EPA SAMPLE NO.

Lab Name: \_\_\_\_\_ Contract: \_\_\_\_\_

Lab Code: \_\_\_\_\_ Case No.: \_\_\_\_\_ SAS No.: \_\_\_\_\_ SDG No.: \_\_\_\_\_

Matrix (soil/water): \_\_\_\_\_ Level (low/med): \_\_\_\_\_

Concentration Units: ug/L

| Analyte   | Control<br>Limit<br>%R | Spiked Sample<br>Result (SSR) | C | Sample<br>Result (SR) | C | Spike<br>Added (SA) | %R | Q | M |
|-----------|------------------------|-------------------------------|---|-----------------------|---|---------------------|----|---|---|
| Aluminum  |                        |                               |   |                       |   |                     |    |   |   |
| Antimony  |                        |                               |   |                       |   |                     |    |   |   |
| Arsenic   |                        |                               |   |                       |   |                     |    |   |   |
| Barium    |                        |                               |   |                       |   |                     |    |   |   |
| Beryllium |                        |                               |   |                       |   |                     |    |   |   |
| Cadmium   |                        |                               |   |                       |   |                     |    |   |   |
| Calcium   |                        |                               |   |                       |   |                     |    |   |   |
| Chromium  |                        |                               |   |                       |   |                     |    |   |   |
| Cobalt    |                        |                               |   |                       |   |                     |    |   |   |
| Copper    |                        |                               |   |                       |   |                     |    |   |   |
| Iron      |                        |                               |   |                       |   |                     |    |   |   |
| Lead      |                        |                               |   |                       |   |                     |    |   |   |
| Magnesium |                        |                               |   |                       |   |                     |    |   |   |
| Manganese |                        |                               |   |                       |   |                     |    |   |   |
| Mercury   |                        |                               |   |                       |   |                     |    |   |   |
| Nickel    |                        |                               |   |                       |   |                     |    |   |   |
| Potassium |                        |                               |   |                       |   |                     |    |   |   |
| Selenium  |                        |                               |   |                       |   |                     |    |   |   |
| Silver    |                        |                               |   |                       |   |                     |    |   |   |
| Sodium    |                        |                               |   |                       |   |                     |    |   |   |
| Thallium  |                        |                               |   |                       |   |                     |    |   |   |
| Vanadium  |                        |                               |   |                       |   |                     |    |   |   |
| Zinc      |                        |                               |   |                       |   |                     |    |   |   |
| Cyanide   |                        |                               |   |                       |   |                     |    |   |   |

Comments:

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## U.S. EPA - CLP

6  
DUPLICATES

EPA SAMPLE NO.

Lab Name: \_\_\_\_\_ Contract: \_\_\_\_\_

Lab Code: \_\_\_\_\_ Case No.: \_\_\_\_\_ SAS No.: \_\_\_\_\_ SDG No.: \_\_\_\_\_

Matrix (soil/water): \_\_\_\_\_ Level (low/med): \_\_\_\_\_

% Solids for Sample: \_\_\_\_\_ % Solids for Duplicate: \_\_\_\_\_

Concentration Units (ug/L or mg/kg dry weight): \_\_\_\_\_

| Analyte   | Control Limit | Sample (S) | C | Duplicate (D) | C | RPD | Q | M |
|-----------|---------------|------------|---|---------------|---|-----|---|---|
| Aluminum  |               |            |   |               |   |     |   |   |
| Antimony  |               |            |   |               |   |     |   |   |
| Arsenic   |               |            |   |               |   |     |   |   |
| Barium    |               |            |   |               |   |     |   |   |
| Beryllium |               |            |   |               |   |     |   |   |
| Cadmium   |               |            |   |               |   |     |   |   |
| Calcium   |               |            |   |               |   |     |   |   |
| Chromium  |               |            |   |               |   |     |   |   |
| Cobalt    |               |            |   |               |   |     |   |   |
| Copper    |               |            |   |               |   |     |   |   |
| Iron      |               |            |   |               |   |     |   |   |
| Lead      |               |            |   |               |   |     |   |   |
| Magnesium |               |            |   |               |   |     |   |   |
| Manganese |               |            |   |               |   |     |   |   |
| Mercury   |               |            |   |               |   |     |   |   |
| Nickel    |               |            |   |               |   |     |   |   |
| Potassium |               |            |   |               |   |     |   |   |
| Selenium  |               |            |   |               |   |     |   |   |
| Silver    |               |            |   |               |   |     |   |   |
| Sodium    |               |            |   |               |   |     |   |   |
| Thallium  |               |            |   |               |   |     |   |   |
| Vanadium  |               |            |   |               |   |     |   |   |
| Zinc      |               |            |   |               |   |     |   |   |
| Cyanide   |               |            |   |               |   |     |   |   |



## U.S. EPA - CLP

7

## LABORATORY CONTROL SAMPLE

Lab Name: \_\_\_\_\_ Contract: \_\_\_\_\_

Lab Code: \_\_\_\_\_ Case No.: \_\_\_\_\_ SAS No.: \_\_\_\_\_ SDG No.: \_\_\_\_\_

Solid LCS Source: \_\_\_\_\_

Aqueous LCS Source: \_\_\_\_\_

| Analyte   | Aqueous (ug/L) |       |    | Solid (mg/kg) |       |   |        |    |
|-----------|----------------|-------|----|---------------|-------|---|--------|----|
|           | True           | Found | %R | True          | Found | C | Limits | %R |
| Aluminum  |                |       |    |               |       |   |        |    |
| Antimony  |                |       |    |               |       |   |        |    |
| Arsenic   |                |       |    |               |       |   |        |    |
| Barium    |                |       |    |               |       |   |        |    |
| Beryllium |                |       |    |               |       |   |        |    |
| Cadmium   |                |       |    |               |       |   |        |    |
| Calcium   |                |       |    |               |       |   |        |    |
| Chromium  |                |       |    |               |       |   |        |    |
| Cobalt    |                |       |    |               |       |   |        |    |
| Copper    |                |       |    |               |       |   |        |    |
| Iron      |                |       |    |               |       |   |        |    |
| Lead      |                |       |    |               |       |   |        |    |
| Magnesium |                |       |    |               |       |   |        |    |
| Manganese |                |       |    |               |       |   |        |    |
| Mercury   |                |       |    |               |       |   |        |    |
| Nickel    |                |       |    |               |       |   |        |    |
| Potassium |                |       |    |               |       |   |        |    |
| Selenium  |                |       |    |               |       |   |        |    |
| Silver    |                |       |    |               |       |   |        |    |
| Sodium    |                |       |    |               |       |   |        |    |
| Thallium  |                |       |    |               |       |   |        |    |
| Vanadium  |                |       |    |               |       |   |        |    |
| Zinc      |                |       |    |               |       |   |        |    |
| Cyanide   |                |       |    |               |       |   |        |    |

## 8 STANDARD ADDITION RESULTS

Contract: \_\_\_\_\_

Case No. : \_\_\_\_\_

**SAS No. :**

SDG No. : \_\_\_\_\_

[illegible]

## U.S. EPA - CLP

9  
ICP SERIAL DILUTIONS

EPA SAMPLE #

Lab Name: \_\_\_\_\_ Contract: \_\_\_\_\_  
Lab Code: \_\_\_\_\_ Case No.: \_\_\_\_\_ SAS No.: \_\_\_\_\_ SDG No.: \_\_\_\_\_  
Matrix (soil/water): \_\_\_\_\_ Level (low/med): \_\_\_\_\_

Concentration Units: ug/L

| Analyte   | Initial Sample<br>Result (I) | C | Serial<br>Dilution<br>Result (S) | C | %<br>Differ-<br>ence | Q | M |
|-----------|------------------------------|---|----------------------------------|---|----------------------|---|---|
| Aluminum  |                              |   |                                  |   |                      |   |   |
| Antimony  |                              |   |                                  |   |                      |   |   |
| Arsenic   |                              |   |                                  |   |                      |   |   |
| Barium    |                              |   |                                  |   |                      |   |   |
| Beryllium |                              |   |                                  |   |                      |   |   |
| Cadmium   |                              |   |                                  |   |                      |   |   |
| Calcium   |                              |   |                                  |   |                      |   |   |
| Chromium  |                              |   |                                  |   |                      |   |   |
| Cobalt    |                              |   |                                  |   |                      |   |   |
| Copper    |                              |   |                                  |   |                      |   |   |
| Iron      |                              |   |                                  |   |                      |   |   |
| Lead      |                              |   |                                  |   |                      |   |   |
| Magnesium |                              |   |                                  |   |                      |   |   |
| Manganese |                              |   |                                  |   |                      |   |   |
| Mercury   |                              |   |                                  |   |                      |   |   |
| Nickel    |                              |   |                                  |   |                      |   |   |
| Potassium |                              |   |                                  |   |                      |   |   |
| Selenium  |                              |   |                                  |   |                      |   |   |
| Silver    |                              |   |                                  |   |                      |   |   |
| Sodium    |                              |   |                                  |   |                      |   |   |
| Thallium  |                              |   |                                  |   |                      |   |   |
| Vanadium  |                              |   |                                  |   |                      |   |   |
| Zinc      |                              |   |                                  |   |                      |   |   |

## U.S. EPA - CLP

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## INSTRUMENT DETECTION LIMITS (QUARTERLY)

Lab Name: \_\_\_\_\_

Contract: \_\_\_\_\_

Lab Code: \_\_\_\_\_

Case No.: \_\_\_\_\_

SAS No.: \_\_\_\_\_

SDG No.: \_\_\_\_\_

ICP ID Number: \_\_\_\_\_

Date: \_\_\_\_\_

Flame AA ID Number: \_\_\_\_\_

Furnace AA ID Number: \_\_\_\_\_

| Analyte   | Wave-length (nm) | Back-ground | CRDL (ug/L) | IDL (ug/L) | M |
|-----------|------------------|-------------|-------------|------------|---|
| Aluminum  |                  |             | 200         |            |   |
| Antimony  |                  |             | 60          |            |   |
| Arsenic   |                  |             | 10          |            |   |
| Barium    |                  |             | 200         |            |   |
| Beryllium |                  |             | 5           |            |   |
| Cadmium   |                  |             | 5           |            |   |
| Calcium   |                  |             | 5000        |            |   |
| Chromium  |                  |             | 10          |            |   |
| Cobalt    |                  |             | 50          |            |   |
| Copper    |                  |             | 25          |            |   |
| Iron      |                  |             | 100         |            |   |
| Lead      |                  |             | 3           |            |   |
| Magnesium |                  |             | 5000        |            |   |
| Manganese |                  |             | 15          |            |   |
| Mercury   |                  |             | 0.2         |            |   |
| Nickel    |                  |             | 40          |            |   |
| Potassium |                  |             | 5000        |            |   |
| Selenium  |                  |             | 5           |            |   |
| Silver    |                  |             | 10          |            |   |
| Sodium    |                  |             | 5000        |            |   |
| Thallium  |                  |             | 10          |            |   |
| Vanadium  |                  |             | 50          |            |   |
| Zinc      |                  |             | 20          |            |   |

Comments:



U.S. EPA - CLP

11A  
ICP INTERELEMENT CORRECTION FACTORS (ANNUALLY)

Lab Name: \_\_\_\_\_ Contract: \_\_\_\_\_  
 Lab Code: \_\_\_\_\_ Case No.: \_\_\_\_\_ SAS No.: \_\_\_\_\_ SDG No.: \_\_\_\_\_  
 ICP ID Number: \_\_\_\_\_ Date: \_\_\_\_\_

| Analyte   | Wave-length (nm) | Interelement Correction Factors for: |    |    |    |   |
|-----------|------------------|--------------------------------------|----|----|----|---|
|           |                  | Al                                   | Ca | Fe | Mg | — |
| Aluminum  |                  |                                      |    |    |    |   |
| Antimony  |                  |                                      |    |    |    |   |
| Arsenic   |                  |                                      |    |    |    |   |
| Barium    |                  |                                      |    |    |    |   |
| Beryllium |                  |                                      |    |    |    |   |
| Cadmium   |                  |                                      |    |    |    |   |
| Calcium   |                  |                                      |    |    |    |   |
| Chromium  |                  |                                      |    |    |    |   |
| Cobalt    |                  |                                      |    |    |    |   |
| Copper    |                  |                                      |    |    |    |   |
| Iron      |                  |                                      |    |    |    |   |
| Lead      |                  |                                      |    |    |    |   |
| Magnesium |                  |                                      |    |    |    |   |
| Manganese |                  |                                      |    |    |    |   |
| Mercury   |                  |                                      |    |    |    |   |
| Nickel    |                  |                                      |    |    |    |   |
| Potassium |                  |                                      |    |    |    |   |
| Selenium  |                  |                                      |    |    |    |   |
| Silver    |                  |                                      |    |    |    |   |
| Sodium    |                  |                                      |    |    |    |   |
| Thallium  |                  |                                      |    |    |    |   |
| Vanadium  |                  |                                      |    |    |    |   |
| Zinc      |                  |                                      |    |    |    |   |

Comments:

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U.S. EPA - CLP

11B

ICP INTERELEMENT CORRECTION FACTORS (ANNUALLY)

Lab Name: \_\_\_\_\_

Contract: \_\_\_\_\_

Lab Code: \_\_\_\_\_

Case No.: \_\_\_\_\_

SAS No.: \_\_\_\_\_

SDG No.: \_\_\_\_\_

ICP ID Number: \_\_\_\_\_

Date: \_\_\_\_\_

| Analyte   | Wave-length (nm) | Interelement Correction Factors for: |   |   |   |   |
|-----------|------------------|--------------------------------------|---|---|---|---|
|           |                  | —                                    | — | — | — | — |
| Aluminum  |                  |                                      |   |   |   |   |
| Antimony  |                  |                                      |   |   |   |   |
| Arsenic   |                  |                                      |   |   |   |   |
| Barium    |                  |                                      |   |   |   |   |
| Beryllium |                  |                                      |   |   |   |   |
| Cadmium   |                  |                                      |   |   |   |   |
| Calcium   |                  |                                      |   |   |   |   |
| Chromium  |                  |                                      |   |   |   |   |
| Cobalt    |                  |                                      |   |   |   |   |
| Copper    |                  |                                      |   |   |   |   |
| Iron      |                  |                                      |   |   |   |   |
| Lead      |                  |                                      |   |   |   |   |
| Magnesium |                  |                                      |   |   |   |   |
| Manganese |                  |                                      |   |   |   |   |
| Mercury   |                  |                                      |   |   |   |   |
| Nickel    |                  |                                      |   |   |   |   |
| Potassium |                  |                                      |   |   |   |   |
| Selenium  |                  |                                      |   |   |   |   |
| Silver    |                  |                                      |   |   |   |   |
| Sodium    |                  |                                      |   |   |   |   |
| Thallium  |                  |                                      |   |   |   |   |
| Vanadium  |                  |                                      |   |   |   |   |
| Zinc      |                  |                                      |   |   |   |   |

Comments:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

## U.S. EPA - CLP

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## ICP LINEAR RANGES (QUARTERLY)

Lab Name: \_\_\_\_\_

Contract: \_\_\_\_\_

Lab Code: \_\_\_\_\_ Case No.: \_\_\_\_\_

SAS No.: \_\_\_\_\_ SDG No.: \_\_\_\_\_

ICP ID Number: \_\_\_\_\_

Date: \_\_\_\_\_

| Analyte   | Integ.<br>Time<br>(Sec.) | Concentration<br>(ug/L) | M |
|-----------|--------------------------|-------------------------|---|
| Aluminum  |                          |                         |   |
| Antimony  |                          |                         |   |
| Arsenic   |                          |                         |   |
| Barium    |                          |                         |   |
| Beryllium |                          |                         |   |
| Cadmium   |                          |                         |   |
| Calcium   |                          |                         |   |
| Chromium  |                          |                         |   |
| Cobalt    |                          |                         |   |
| Copper    |                          |                         |   |
| Iron      |                          |                         |   |
| Lead      |                          |                         |   |
| Magnesium |                          |                         |   |
| Manganese |                          |                         |   |
| Mercury   |                          |                         |   |
| Nickel    |                          |                         |   |
| Potassium |                          |                         |   |
| Selenium  |                          |                         |   |
| Silver    |                          |                         |   |
| Sodium    |                          |                         |   |
| Thallium  |                          |                         |   |
| Vanadium  |                          |                         |   |
| Zinc      |                          |                         |   |

Comments:

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U.S. EPA - CLP  
13  
PREPARATION LOG

Lab Name: \_\_\_\_\_ Contract: \_\_\_\_\_  
Lab Code: \_\_\_\_\_ Case No.: \_\_\_\_\_ SAS No.: \_\_\_\_\_ SDG No.: \_\_\_\_\_  
Method: \_\_\_\_\_

[illegible]





# SAMPLE LOG-IN SHEET

|                          |  |                     |
|--------------------------|--|---------------------|
| Lab Name                 |  | Page _____ of _____ |
| Received By (Print Name) |  | Log-in Date         |
| Received By (Signature)  |  |                     |

|             |                           |            |
|-------------|---------------------------|------------|
| Case Number | Sample Delivery Group No. | SAS Number |
|-------------|---------------------------|------------|

| Remarks:  | EPA Sample # | Corresponding |                | Remarks:<br>Condition of Sample Shipment, etc. |
|---|--------------|---------------|----------------|--|
|   |              | Sample Tag #  | Assigned Lab # |  |
| 1. Custody Seal(s) Present/Absent*<br>Intact/Broken                                     |              |               |                |  |
| 2. Custody Seal Nos.: _____   |              |               |                |  |
| 3. Chain-of-Custody Records Present/Absent*   |              |               |                |  |
| 4. Traffic Reports or Packing Lists Present/Absent*                                     |              |               |                |  |
| 5. Airbill Airbill/Sticker Present/Absent*  |              |               |                |  |
| 6. Airbill No.: _____   |              |               |                |  |
| 7. Sample Tags Present/Absent*  |              |               |                |  |
| Sample Tag Numbers Listed/Not Listed on Chain-of-Custody                                |              |               |                |  |
| 8. Sample Condition: Intact/Broken*/Leaking   |              |               |                |  |
| 9. Does information on custody records, traffic reports, and sample tags agree? Yes/No* |              |               |                |  |
| 10. Date Received at Lab: _____   |              |               |                |  |
| 11. Time Received: _____  |              |               |                |  |
| Sample Transfer   |              |               |                |  |
| Fraction  | Fraction     |               |                |  |
| Area #  | Area #       |               |                |  |
| By  | By           |               |                |  |
| On  | On           |               |                |  |

\* Contact SMO and attach record of resolution.

|             |                  |
|-------------|------------------|
| Received By | Logbook No.      |
| Date        | Logbook Page No. |

FULL INORGANICS  
COMPLETE SDG FILE (CSF)  
INVENTORY SHEET

Lab Name: \_\_\_\_\_ City/State: \_\_\_\_\_

Case No. \_\_\_\_\_ SDG No. \_\_\_\_\_ SDG Nos. to Follow: \_\_\_\_\_

SAS No. \_\_\_\_\_ Contract No. \_\_\_\_\_ SOW No. \_\_\_\_\_

All documents delivered in the Complete SDG File must be original documents where possible. (Reference Exhibit B, Section II D and Section III V)

|   | Page Nos. |    | (Please Check:) |        |
|---|-----------|----|-----------------|--------|
|   | From      | To | Lab             | Region |
| 1. Inventory Sheet (DC-2) (Do not number)                         |           |    |                 |        |
| 2. Cover Page   |           |    |                 |        |
| 3. Inorganic Analysis<br>Data Sheet (Form I-IN)                   |           |    |                 |        |
| 4. Initial & Continuing Calibration<br>Verification (Form IIA-IN) |           |    |                 |        |
| 5. CRDL Standards For AA and ICP<br>(Form IIB-IN)                 |           |    |                 |        |
| 6. Blanks (Form III-IN)   |           |    |                 |        |
| 7. ICP Interference Check<br>Sample (Form IV-IN)                  |           |    |                 |        |
| 8. Spike Sample Recovery (Form VA-IN)                             |           |    |                 |        |
| 9. Post Digest Spike<br>Sample Recovery (Form VB-IN)              |           |    |                 |        |
| 10. Duplicates (Form VI-IN)                                       |           |    |                 |        |
| 11. Laboratory Control Sample<br>(Form VII-IN)                    |           |    |                 |        |
| 12. Standard Addition Results<br>(Form VIII-IN)                   |           |    |                 |        |
| 13. ICP Serial Dilutions (Form IX-IN)                             |           |    |                 |        |
| 14. Instrument Detection Limits<br>(Form X-IN)                    |           |    |                 |        |
| 15. ICP Interelement Correction Factors<br>(Form XIA-IN)          |           |    |                 |        |
| 16. ICP Interelement Correction Factors<br>(Form XIB-IN)          |           |    |                 |        |
| 17. ICP Linear Ranges (Form XII-IN)                               |           |    |                 |        |
| 18. Preparation Log (Form XIII-IN)                                |           |    |                 |        |
| 19. Analysis Run Log (Form XIV-IN)                                |           |    |                 |        |
| 20. ICP Raw Data  |           |    |                 |        |
| 21. Furnace AA Raw Data   |           |    |                 |        |
| 22. Mercury Raw Data  |           |    |                 |        |

|   | Page Nos. |       | (Please Check:) |        |
|---|-----------|-------|-----------------|--------|
|   | From      | To    | Lab             | Region |
| 23. Cyanide Raw Data  | _____     | _____ | _____           | _____  |
| 24. Preparation Logs Raw Data   | _____     | _____ | _____           | _____  |
| 25. Percent Solids Determination Log  | _____     | _____ | _____           | _____  |
| 26. Traffic Report  | _____     | _____ | _____           | _____  |
| 27. EPA Shipping/Receiving Documents  | _____     | _____ | _____           | _____  |
| Airbill (No. of Shipments _____)  | _____     | _____ | _____           | _____  |
| Chain-of-Custody Records  | _____     | _____ | _____           | _____  |
| Sample Tags   | _____     | _____ | _____           | _____  |
| Sample Log-In Sheet (Lab & DCI)   | _____     | _____ | _____           | _____  |
| SDG Cover Sheet   | _____     | _____ | _____           | _____  |
| 28. Misc. Shipping/Receiving Records  | _____     | _____ | _____           | _____  |
| (list all individual records)   | _____     | _____ | _____           | _____  |
| Telephone Logs  | _____     | _____ | _____           | _____  |
| 29. Internal Lab Sample Transfer Records & Tracking Sheets (describe or list) | _____     | _____ | _____           | _____  |
| 30. Internal Original Sample Prep & Analysis Records (describe or list)       | _____     | _____ | _____           | _____  |
| Prep Records _____  | _____     | _____ | _____           | _____  |
| Analysis Records _____  | _____     | _____ | _____           | _____  |
| Description _____   | _____     | _____ | _____           | _____  |
| 31. Other Records (describe or list)  | _____     | _____ | _____           | _____  |
| Telephone Communication Log   | _____     | _____ | _____           | _____  |
| 32. Comments:   | _____     | _____ | _____           | _____  |

Completed by (CLP Lab):

\_\_\_\_\_  
(Signature)

\_\_\_\_\_  
(Print Name & Title)

\_\_\_\_\_  
(Date)

Audited by (EPA):

\_\_\_\_\_  
(Signature)

\_\_\_\_\_  
(Print Name & Title)

\_\_\_\_\_  
(Date)





EXHIBIT C

INORGANIC TARGET ANALYTE LIST



# INORGANIC TARGET ANALYTE LIST (TAL)

| Analyte   | Contract Required<br>Detection Limit (1,2)<br>(ug/L) |
|-----------|--|
| Aluminum  | 200  |
| Antimony  | 60   |
| Arsenic   | 10   |
| Barium    | 200  |
| Beryllium | 5  |
| Cadmium   | 5  |
| Calcium   | 5000   |
| Chromium  | 10   |
| Cobalt    | 50   |
| Copper    | 25   |
| Iron      | 100  |
| Lead      | 3  |
| Magnesium | 5000   |
| Manganese | 15   |
| Mercury   | 0.2  |
| Nickel    | 40   |
| Potassium | 5000   |
| Selenium  | 5  |
| Silver    | 10   |
| Sodium    | 5000   |
| Thallium  | 10   |
| Vanadium  | 50   |
| Zinc      | 20   |
| Cyanide   | 10   |

- (1) Subject to the restrictions specified in the first page of Part G, Section IV of Exhibit D (Alternate Methods - Catastrophic Failure) any analytical method specified in SOW Exhibit D may be utilized as long as the documented instrument or method detection limits meet the Contract Required Detection Limit (CRDL) requirements. Higher detection limits may only be used in the following circumstance:

If the sample concentration exceeds five times the detection limit of the instrument or method in use, the value may be reported even though the instrument or method detection limit may not equal the Contract Required Detection Limit. This is illustrated in the example below:

For lead:

Method in use = ICP

Instrument Detection Limit (IDL) = 40

Sample concentration = 220

Contract Required Detection Limit (CRDL) = 3



The value of 220 may be reported even though the instrument detection limit is greater than CRDL. The instrument or method detection limit must be documented as described in Exhibits B and E.

- (2) The CRDLs are the instrument detection limits obtained in pure water that must be met using the procedure in Exhibit E. The detection limits for samples may be considerably higher depending on the sample matrix.

## EXHIBIT D

### ANALYTICAL METHODS

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|---|-----------------|
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## SECTION I

## INTRODUCTION

Inorganic Methods Flow Chart: Figure I outlines the general analytical scheme the Contractor will follow in performing analyses under this contract.

Permitted Methods: Subject to the restrictions specified in Section IV, Part G - Alternate Methods (Catastrophic ICP Failure), any analytical method specified in Exhibit D may be used as long as the documented instrument or method detection limits meet the Contract Required Detection Limits (Exhibit C). Analytical methods with higher detection limits may be used only if the sample concentration exceeds five times the documented detection limit of the instrument or method.

Initial Run Undiluted: All samples must initially be run undiluted (i.e., final product of the sample preparation procedure). When an analyte concentration exceeds the calibrated or linear range (as appropriate), re-analysis for that analyte(s) is required after appropriate dilution. The Contractor must use the least dilution necessary to bring the analyte(s) within the valid analytical range (but not below the CRDL) and report the highest valid value for each analyte as measured from the undiluted and diluted analyses. Unless the Contractor can submit proof that dilution was required to obtain valid results, both diluted and undiluted sample measurements must be contained in the raw data. ICP data showing a high concentration for a particular analyte, combined with an analyte result that is close to the middle range of the calibration curve in the diluted sample, constitute sufficient proof that the sample had to initially be run diluted for that analyte on a furnace AA instrument. All sample dilutions shall be made with deionized water appropriately acidified to maintain constant acid strength.

Quality Assurance/Quality Control Measurements: The Contractor is reminded and cautioned that Exhibit D is a compendium of required and/or permitted analytical methods to be used in the performance of analyses under this contract. The quality assurance/quality control procedures or measurements to be performed in association with these methods or analyses are specified in Exhibit E. In the event references to quality assurance measurements in any of the methods appear to be in conflict with or to be less stringent than the requirements of Exhibit E, the requirements of Exhibit E will prevail.

Raw Data Requirements: The Contractor is reminded and cautioned that the collection and provision of raw data may or may not be referred to within the individual methods of Exhibit D or the Quality Assurance Protocol of Exhibit E. The Raw Data Deliverables requirements are specified in Exhibit B, Section II.D.2.d. Raw data collected and provided in association with the performance of analyses under this contract shall conform to the appropriate provisions of Exhibit B.

Glassware Cleaning: Lab glassware to be used in metals analysis must be acid cleaned according to EPA's manual "Methods for Chemical Analysis of Water and Wastes" or an equivalent procedure.

Standard Stock Solutions: Stock solutions to be used for preparing instrument or method calibration standards may be purchased or prepared as described in the individual methods of Exhibit D. All other solutions to be used for Quality Assurance/Quality Control measurements shall conform to the specific requirements of Exhibit E.



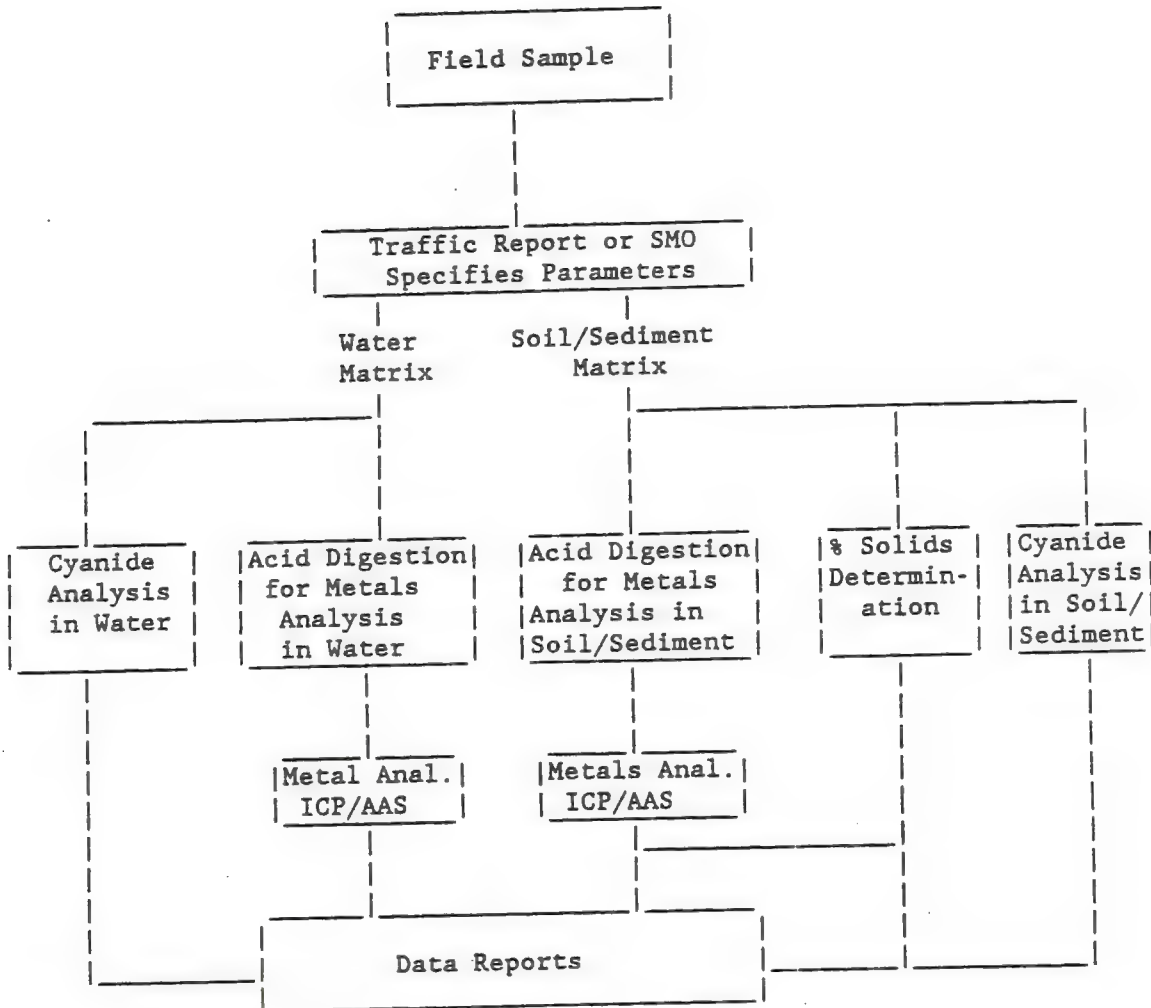
Aqueous Sample pH Measurement: Before sample preparation is initiated on an aqueous sample received in shipment, the Contractor must check the pH of the sample and note in a preparation log if the pH is  $<2$  for a metals sample or if the pH is  $>12$  for a cyanide sample. The Contractor shall not perform any pH adjustment action if the sample has not been properly preserved. If the sample has not been preserved, contact SMO before proceeding with the preparation and analysis for further instructions.

Sample Mixing: Unless instructed otherwise by the EPA Administrative Project Officer or Technical Project Officer, all samples shall be mixed thoroughly prior to aliquoting for digestion. No specific procedure is provided herein for homogenization of soil/sediment samples; however, an effort should be made to obtain a representative aliquot.

Background Corrections: Background corrections are required for Flame AA measurements below 350 nm and for all Furnace AA measurements. For ICP background correction requirements, see Exhibit D Section IV, Part A, paragraph 2.1.

Replicate Injections/Exposures: Each furnace analysis requires a minimum of two injection (burns), except for full method of standard addition (MSA). All ICP measurements shall require a minimum of two replicate exposures. Appropriate hard copy raw data for each exposure/injection shall be included in the data package in accordance with Exhibit B, Section II, Part D, paragraph 2.d. The average of each set of exposures/injections shall be used for standardization, sample analysis, and reporting as specified in Exhibit D.

Figure 1  
INORGANICS METHODS FLOW CHART



## SECTION II

## SAMPLE PRESERVATION AND HOLDING TIMES

A. SAMPLE PRESERVATION

## 1. Water Sample Preservation

| <u>Measurement<br/>Parameter</u>                  | <u>Container</u> <sup>(1)</sup> | <u>Preservative</u> <sup>(2)</sup>   |
|---|---------------------------------|--|
| Metals  | P,G                             | HNO <sub>3</sub> to pH <2  |
| Cyanide, total<br>and amenable<br>to chlorination | P,G                             | 0.6g ascorbic acid(3)<br>NaOH to pH >12<br>Cool, maintain at 4°C(±2°C)<br>until analysis |

FOOTNOTES:

- (1) Polyethylene (P) or glass (G).
- (2) Sample preservation is performed by the sampler immediately upon sample collection.
- (3) Only used in the presence of residual chlorine.

## 2. Soil/Sediment Sample Preservation

The preservation required for soil/sediment samples is maintenance at 4°C (± 2°) until analysis.

B. HOLDING TIMES FOR WATER AND SOIL/SEDIMENT SAMPLES

Following are the maximum sample holding times allowable under this contract. To be compliant with this contract, the Contractor must analyze samples within these times even if these times are less than the maximum data submission times allowed in this contract.

| <u>Analyte</u>              | No. of Days Following<br>Sample Receipt<br>by Contractor |
|-----------------------------|--|
| Mercury                     | 26 days  |
| Metals (other than mercury) | 180 days   |
| Cyanide                     | 12 days  |

## SECTION III

## SAMPLE PREPARATION

A. WATER SAMPLE PREPARATION

## 1. Acid Digestion Procedure for Furnace Atomic Absorption Analysis

Shake sample and transfer 100 mL of well-mixed sample to a 250-mL beaker, add 1 mL of (1+1)  $\text{HNO}_3$  and 2 mL 30%  $\text{H}_2\text{O}_2$  to the sample. Cover with watch glass or similar cover and heat on a steam bath or hot plate for 2 hours at  $95^\circ\text{C}$  or until sample volume is reduced to between 25 and 50 mL, making certain sample does not boil. Cool sample and filter to remove insoluble material. (NOTE: In place of filtering, the sample, after dilution and mixing, may be centrifuged or allowed to settle by gravity overnight to remove insoluble material.) Adjust sample volume to 100 mL with deionized distilled water. The sample is now ready for analysis.

Concentrations so determined shall be reported as "total."

If Sb is to be determined by furnace AA, use the digestate prepared for ICP/flame AA analysis.

## 2. Acid Digestion Procedure for ICP and Flame AA Analyses

Shake sample and transfer 100 mL of well-mixed sample to a 250-mL beaker, add 2 mL of (1+1)  $\text{HNO}_3$  and 10 mL of (1+1)  $\text{HCl}$  to the sample. Cover with watch glass or similar cover and heat on a steam bath or hot plate for 2 hours at  $95^\circ\text{C}$  or until sample volume is reduced to between 25 and 50 mL, making certain sample does not boil. Cool sample and filter to remove insoluble material. (NOTE: In place of filtering, the sample, after dilution and mixing, may be centrifuged or allowed to settle by gravity overnight to remove insoluble material.) Adjust sample volume to 100 mL with deionized distilled water. The sample is now ready for analysis.

Concentrations so determined shall be reported as "total."

B. SOIL/SEDIMENT SAMPLE PREPARATION

## 1. Acid Digestion Procedure for ICP, Flame AA and Furnace AA Analyses

## a. Scope and Application

This method is an acid digestion procedure used to prepare sediments, sludges, and soil samples for analysis by flame or furnace atomic absorption spectroscopy (AAS) or by inductively coupled plasma spectroscopy (ICP). Samples prepared by this method may be analyzed by AAS or ICP for the following metals:



|           |           |           |
|-----------|-----------|-----------|
| Aluminum  | Chromium  | Potassium |
| Antimony  | Cobalt    | Selenium  |
| Arsenic   | Copper    | Silver    |
| Barium    | Iron      | Sodium    |
| Beryllium | Lead      | Thallium  |
| Cadmium   | Magnesium | Vanadium  |
| Calcium   | Manganese | Zinc      |
|           | Nickel    |           |

b. Summary of Method

A representative 1 g (wet weight) sample is digested in nitric acid and hydrogen peroxide. The digestate is then refluxed with either nitric acid or hydrochloric acid. Hydrochloric acid is used as the final reflux acid for the furnace AA analysis of Sb, the Flame AA or ICP analysis of Al, Sb, Ba, Be, Ca, Cd, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Ag, Na, Tl, V and Zn. Nitric acid is employed as the final reflux acid for the Furnace AA analysis of As, Be, Cd, Cr, Co, Cu, Fe, Pb, Mn, Ni, Se, Ag, Tl, V, and Zn. A separate sample shall be dried for a percent solids determination (Section IV, Part F).

c. Apparatus and Materials

- (1) 250 mL beaker or other appropriate vessel
- (2) Watch glasses
- (3) Thermometer that covers range of 0° to 200°C
- (4) Whatman No. 42 filter paper or equivalent

d. Reagents

- (1) ASTM Type II water (ASTM D1193): Water must be monitored.
- (2) Concentrated nitric acid (sp. gr. 1.41)
- (3) Concentrated hydrochloric acid (sp. gr. 1.19)
- (4) Hydrogen Peroxide (30%)

e. Sample Preservation and Handling

Soil/sediment (nonaqueous) samples must be refrigerated at 4°C ( $\pm 2^\circ$ ) from receipt until analysis.

## f. Procedure

- (1) Mix the sample thoroughly to achieve homogeneity. For each digestion procedure, weigh (to the nearest 0.01g) a 1.0 to 1.5 g portion of sample and transfer to a beaker.
- (2) Add 10 mL of 1:1 nitric acid ( $\text{HNO}_3$ ), mix the slurry, and cover with a watch glass. Heat the sample to  $95^\circ\text{C}$  and reflux for 10 minutes without boiling. Allow the sample to cool, add 5 mL of concentrated  $\text{HNO}_3$ , replace the watch glass, and reflux for 30 minutes. Do not allow the volume to be reduced to less than 5 mL while maintaining a covering of solution over the bottom of the beaker.
- (3) After the second reflux step has been completed and the sample has cooled, add 2 mL of Type II water and 3 mL of 30% hydrogen peroxide ( $\text{H}_2\text{O}_2$ ). Return the beaker to the hot plate for warming to start the peroxide reaction. Care must be taken to ensure that losses do not occur due to excessively vigorous effervescence. Heat until effervescence subsides, and cool the beaker.
- (4) Continue to add 30%  $\text{H}_2\text{O}_2$  in 1 mL aliquots with warming until the effervescence is minimal or until the general sample appearance is unchanged. (NOTE: Do not add more than a total of 10 mL 30%  $\text{H}_2\text{O}_2$ .)
- (5a) If the sample is being prepared for the furnace AA analysis of Sb, the flame AA or ICP analysis of Al, Sb, Ba, Be, Ca, Cd, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Ag, Na, Tl, V, and Zn, add 5 mL of 1:1 HCl and 10 mL of Type II water, return the covered beaker to the hot plate, and heat for an additional 10 minutes. After cooling, filter through Whatman No. 42 filter paper (or equivalent) and dilute to 100 mL with Type II water. NOTE: In place of filtering, the sample (after dilution and mixing) may be centrifuged or allowed to settle by gravity overnight to remove insoluble material. The diluted sample has an approximate acid concentration of 2.5% (v/v) HCl and 5% (v/v)  $\text{HNO}_3$ . Dilute the digestate 1:1 (200 mL final volume) with acidified water to maintain constant acid strength. The sample is now ready for analysis.
- (5b) If the sample is being prepared for the furnace analysis of As, Be, Cd, Cr, Co, Cu, Fe, Pb, Mn, Ni, Se, Ag, Tl, V, and Zn, continue heating the acid-peroxide digestate until the volume has been reduced to approximately 2 mL, add 10 mL of Type II water, and warm the mixture. After cooling, filter through Whatman No. 42 filter paper (or equivalent) and dilute the sample to 100 mL with Type II water (or centrifuge the sample). NOTE: In place of filtering, the sample (after dilution and

mixing) may be centrifuged or allowed to settle by gravity overnight to remove insoluble material. The diluted digestate solution contains approximately 2% (v/v)  $\text{HNO}_3$ . Dilute the digestate 1:1 (200 mL final volume) with acidified water to maintain constant acid strength. For analysis, withdraw aliquots of appropriate volume, and add any required reagent or matrix modifier. The sample is now ready for analysis.

g. Calculations

- (1) A separate determination of percent solids must be performed (Section IV, Part F).
- (2) The concentrations determined in the digest are to be reported on the basis of the dry weight of the sample.

$$\text{Concentration (dry wt.) (mg/kg)} = \frac{C \times V}{W \times S}$$

Where,

C - Concentration (mg/L)  
 V - Final volume in liters after sample preparation  
 W - Weight in kg of wet sample  
 S - % Solids/100

C. TOTAL METALS SAMPLE PREPARATION USING MICROWAVE DIGESTION

1. SCOPE AND APPLICATION

This method is an acid digestion procedure using microwave energy to prepare water and soil samples for analysis by GFAA, ICP, or Flame AA for the following metals:

|           |           |           |
|-----------|-----------|-----------|
| Aluminum  | Chromium  | Potassium |
| Antimony* | Cobalt    | Selenium  |
| Arsenic   | Copper    | Silver    |
| Barium    | Iron      | Sodium    |
| Beryllium | Lead      | Thallium  |
| Cadmium   | Magnesium | Vanadium  |
| Calcium   | Manganese | Zinc      |
|           | Nickel    |           |

\*NOTE: This microwave digestion method is not appropriate for the quantitative recovery of Antimony from soil and sediment samples.

## 2. SUMMARY OF METHOD

a. Water Sample Preparation

A representative 45 mL water sample is digested in 5 mL of concentrated nitric acid in a Teflon<sup>R</sup> PFA vessel for 20 minutes using microwave heating. The digestate is then filtered to remove insoluble material. The sample may be centrifuged or allowed to settle by gravity overnight to remove insoluble material.

b. Soil Sample Preparation

A representative 0.5 g (wet weight) sample is digested in 10 mL of concentrated nitric acid in a Teflon<sup>R</sup> PFA vessel for 10 minutes using microwave heating. The digestate is then filtered to remove insoluble material. The sample may be centrifuged or allowed to settle by gravity overnight to remove insoluble material. NOTE: This microwave digestion method is not appropriate for the quantitative recovery of Antimony from soil and sediment samples.

## 3. APPARATUS AND MATERIALS

- a. Commercial kitchen or home-use microwave ovens shall not be used for the digestion of samples under this contract. The oven cavity must be corrosion resistant and well ventilated. All electronics must be protected against corrosion for safe operation.
- b. Microwave oven with programmable power settings up to at least 600 Watts.
- c. The system must use PFA Teflon<sup>R</sup> digestion vessels (120 mL capacity) capable of withstanding pressures of up to 110  $\pm$  10 psi (7.5  $\pm$  0.7 atm). These vessels are capable of controlled pressure relief at pressures exceeding 110 psi.
- d. A rotating turntable must be used to ensure homogeneous distribution of microwave radiation within the oven. The speed of the turntable must be a minimum of 3 rpm.
- e. Polymeric volumetric ware in plastic (Teflon<sup>R</sup> or polyethylene) 50 mL or 100 mL capacity.
- f. Whatman No. 41 filter paper (or equivalent).
- g. Disposable polypropylene filter funnel.
- h. Analytical balance, 300 g capacity, and minimum  $\pm$  0.01 g.
- i. Polyethylene bottles, 125 mL, with caps.

## 4. REAGENTS

- a. ASTM Type II water (ASTM D1193): water must be monitored.
- b. Sub-boiled, concentrated nitric acid (sp. gr. 1.41).
- c. Concentrated hydrochloric acid (sp. gr. 1.19).



## 5. MICROWAVE CALIBRATION PROCEDURE

- a. The calibration procedure is a critical step prior to the use of any microwave unit. The microwave unit must be calibrated every six months. The calibration data for each calibration must be available for review during on-site audits. In order that absolute power settings may be interchanged from one microwave unit to another, the actual delivered power must be determined.

Calibration of a laboratory microwave unit depends on the type of electronic system used by the manufacturer. If the unit has a precise and accurate linear relationship between the output power and the scale used in controlling the microwave unit, then the calibration can be a two-point calibration at maximum and 40% power. If the unit is not accurate or precise for some portion of the controlling scale, then a multiple-point calibration is necessary. If the unit power calibration needs a multiple point calibration, then the point where linearity begins must be identified. For example: a calibration at 100, 99, 98, 97, 95, 90, 80, 70, 60, 50 and 40% power settings can be applied and the data plotted. The non-linear portion of the calibration curve can be excluded or restricted in use. Each percent is equivalent to approximately 5.5 - 6 watts and becomes the smallest unit of power that can be controlled. If 20 - 40 watts are contained from 99-100%, that portion of the microwave calibration is not controllable by 3-7 times that of the linear portion of the control scale and will prevent duplication of precise power conditions specified in that portion of the power scale.

The power available for heating is evaluated so that the absolute power setting (watts) may be compared from one microwave to another. This is accomplished by measuring the temperature rise in 1 Kg of water exposed to microwave radiation for a fixed period of time. The water is placed in a Teflon<sup>R</sup> beaker (or a beaker that is made of some other material that does not adsorb microwave energy) and stirred before measuring the temperature. Glass beakers adsorb microwave energy and may not be used. The initial temperature of the water must be between 19 and 25 °C. The beaker is circulated continuously through the field for at least two (2) minutes at full power. The beaker is removed from the microwave, the water is stirred vigorously, and the final temperature recorded. The final reading is

the maximum temperature reading after each energy exposure. These measurements must be accurate to  $\pm 0.1^\circ\text{C}$  and made within 30 seconds of the end of heating. If more measurements are needed, do not use the same water until it has cooled down to room temperature. Otherwise, use a fresh water sample.

The absorbed power is determined by the following formula:

$$P = \frac{(K) (C_p) (m) (DT)}{t}$$

Where:

P - The apparent power absorbed by the sample in watts (joules per second),

K - The conversion factor for thermochemical calories per second to watts (-4.184),

C<sub>p</sub> - The heat capacity, thermal capacity, or specific heat (cal. g<sup>-1</sup>.°C<sup>-1</sup>) of water (-1.0),

m - The mass of the sample in grams (g),

DT - the final temperature minus the initial temperature (°C), and

t - the time in seconds (s)

Using 2 minutes and 1 Kg of distilled water, the calibration equation simplifies to:

$$P = (DT) (34.87).$$

The microwave user can now relate power in watts to the percent power setting of the microwave

#### CLEANING PROCEDURE

##### The initial cleaning of the PFA vessels:

- 1) Prior to first use - new vessels must be annealed before they are used. A pretreatment/cleaning procedure must be followed. This procedure calls for heating the vessels for 96 hours at 200°C. The vessels must be disassembled during annealing and the sealing surfaces (the top of the vessel or its rim) must not be used to support the vessel during annealing.
- 2) Rinse in ASTM Type I water.

- (3) Immerse in 1:1 HCl for a minimum of 3 hours after the cleaning bath has reached a temperature just below boiling.
- (4) Rinse in ASTM Type I water.
- (5) Immerse in 1:1 HNO<sub>3</sub> for a minimum of 3 hours after the cleaning bath has reached a temperature just below boiling.
- (6) The vessels are then rinsed with copious amounts of ASTM Type I water prior to use for any analyses under this contract.

b. Cleaning procedure between sample digestions

- (1) Wash entire vessel in hot water using laboratory-grade nonphosphate detergent.
- (2) Rinse with 1:1 nitric acid.
- (3) Rinse three times with ASTM Type I water. If contaminants are found in the preparation blank, it is mandatory that steps a(2) through a(6) be strictly adhered to.

7. DIGESTION PROCEDURE

a. Water Sample Digestion Procedure

- (1) A 45 mL aliquot of the sample are measured into Teflon<sup>R</sup> digestion vessels using volumetric glassware.
- (2) 5 mL of high purity concentrated HNO<sub>3</sub> is added to the digestion vessels.
- (3) The caps with the pressure release valves are placed on the vessels hand tight and then tightened, using constant torque, to 12 ft./lbs. The weight of each vessel is recorded to 0.02 g.
- (4) Place 5 sample vessels in the carousel, evenly spaced around its periphery in the microwave unit. Venting tubes connect each sample vessel with a collection vessel. Each sample vessel is attached to a clean, double-ported vessel to collect any sample expelled from the sample vessel in the event of over pressurization. Assembly of the vessels into the carousel may be done inside or outside the microwave.
- (5) This procedure is energy balanced for five 45 mL water samples (each with 5 mL of acid) to produce consistent conditions. When fewer than 5 samples are digested, the remaining vessels must be filled with 45 mL of tap, DI or Type II water and 5 mL of concentrated nitric acid.

Newer microwave ovens may be capable of higher power settings which may allow

a larger number of samples. If the analyst wishes to digest more than 5 samples at a time, the analyst may use different power settings as long as they result in the same time temperature conditions defined in the power programming for this method.

The initial temperature of the samples should be  $24 \pm 1^\circ\text{C}$ . The preparation blank must have 45 mL of deionized water and the same amount (5 mL) of acid that is added to the samples.

The microwave unit first-stage program must be set to give 545 watts for 10 minutes and the second-stage program to give 344 watts for 10 minutes. This sequence brings the samples to  $160 \pm 4^\circ\text{C}$  in ten minutes and permits a slow rise to  $165\text{--}170^\circ\text{C}$  during the second 10 minutes.

- (6) Following the 20 minute program, the samples are left to cool in the microwave unit for five minutes, with the exhaust fan ON. The samples and/or carousel may then be removed from the microwave unit. Before opening the vessels, let cool until they are no longer hot to the touch.
- (7) After the sample vessel has cooled, weigh the sample vessel and compare to the initial weight as reported in the preparation log. Any sample vessel exhibiting a  $\leq 0.5$  g loss must have any excess sample from the associated collection vessel added to the original sample vessel before proceeding with the sample preparation. Any sample vessel exhibiting a  $> 0.5$  g loss must be identified in the preparation log and the sample redigested.
- (9) Sample Filtration:

The digested samples are shaken well to mix in any condensate within the digestion vessel before being opened. The digestates are then filtered into 50 mL glass volumetric flasks through ultra-clean filter paper and diluted to 50 mL (if necessary). The samples are now ready for analysis. The sample results must be corrected by a factor of 1.11 in order to report final concentration values based on an initial volume of 45 mL. Concentrations so determined shall be reported as "total."

b. Soil Sample Digestion Procedure

- (1) Add a representative  $0.5 \pm 0.050$  grams of sample to the Teflon<sup>R</sup> PFA vessel.
- (2) Add  $10 \pm 0.1$  mL of concentrated nitric acid. If a vigorous reaction occurs, allow the reaction to stop before capping the vessel.
- (3) Cap the vessel, then tighten using constant torque to 12 ft/lbs, according to the manufacturer's direction.
- (4) Connect the sample vessel to the overflow vessel using Teflon<sup>R</sup> PFA tubing.
- (5) Weigh the vessel assembly to the nearest 0.01g.



- (6) Place sample vessels in groups of 2 sample vessels or 6 sample vessels in the carousel, evenly spaced around its periphery in the microwave unit. If fewer than the recommended number of samples are to be digested, i.e. 3 samples plus 1 blank then the remaining vessels must be filled with 10 mL of nitric acid to achieve the full complement of vessels.

Each sample vessel must be attached to a clean, double-ported vessel to collect any sample expelled from the sample vessel in the event of over pressurization. Assembly of the vessels into the carousel may be done inside or outside the microwave. Connect the overflow vessel to the center well of the oven.

- (7) The preparation blank must have 0.5 mL of deionized water and the same amount (10 mL) of acid that is added to the samples. The preparation blank must later be diluted to 50 mL in the same manner as the samples.
- (8) Irradiate the 2 sample vessel group at 344 watts for 10 minutes, or the 6-sample vessel group at 574 watts for 10 minutes.

This program brings the samples to 175°C in 5.5 minutes, and remains between 170-180°C for the balance of the 10 minute irradiation period. The pressure should peak at less than 6 atm for most samples. The pressure may exceed these limits in the case of high concentrations of carbonate or organic compounds. In these cases, the pressure will be limited by the relief pressure of the vessel to  $7.5 \pm 0.7$  atm.

- (9) Allow the vessels to cool for a minimum of five minutes before removing them from the microwave unit, with exhaust fan ON. Allow the vessels to cool to room temperature before opening. The vessels must be carefully vented and uncapped in a fume hood.
- (10) Weigh each vessel assembly. If the weight of acid plus the sample has decreased by more than 10% from the original weight, discard the digests. Determine the reason for the loss. Losses typically are attributed to use of digestion time longer than ten minutes, using too large of a sample, or having improper heating conditions. Once the source of the losses has been corrected, prepare a new set of samples for digestion.
- (11) Sample Filtration:

Shake the sample well to mix in any condensate within the digestion vessel before being opened. Filter the digestion vessel into a 50 mL glass volumetric flask through ultra-clean filter paper. Rinse the sample digestion vessel, cap, connecting tube, and (if venting occurred) the overflow vessel

into the 50 mL glass flask. Dilute to 50 mL. The samples are now ready for analysis. Concentrations so determined shall be reported as "total."

(12) Calculations:

The concentrations determined in the digest are to be reported on the basis of the dry weight of the sample.

$$\text{Concentration (dry wt.) (mg/Kg)} = \frac{C \times V}{W \times S}$$

Where

- C - Concentration (mg/L)
- V - Final volume in liters after sample preparation
- W - Weight in kg of wet sample
- S - % Solids/100

D. MERCURY AND CYANIDE PREPARATION

Refer to each specific method in this Exhibit for mercury and cyanide preparations.

PART A - INDUCTIVELY COUPLED PLASMA-ATOMIC EMISSION SPECTROMETRIC METHOD<sup>+</sup>

Method 200.7 CLP-M\*  
INDUCTIVELY COUPLED PLASMA-ATOMIC EMISSION SPECTROMETRIC METHOD  
FOR TRACE ELEMENT ANALYSIS OF WATER AND WASTES

1. Scope and Application

- 1.1 Dissolved elements are determined in filtered and acidified samples. Appropriate steps must be taken in all analyses to ensure that potential interferences are taken into account. This is especially true when dissolved solids exceed 1500 mg/L. (See 5.)
- 1.2 Total elements are determined after appropriate digestion procedures are performed. Since digestion techniques increase the dissolved solids content of the samples, appropriate steps must be taken to correct for potential interference effects. (See 5.)
- 1.3 Table 1 lists elements along with recommended wavelengths and typical estimated instrumental detection limits using conventional pneumatic nebulization. Actual working detected limits are sample dependent and as the sample matrix varies, these concentrations may also vary. In time, other elements may be added as more information becomes available and as required.
- 1.4 Because of the differences between various makes and models of satisfactory instruments, no detailed instrumental operating instructions can be provided. Instead, the analyst is referred to the instructions provided by the manufacturer of the particular instrument.

2. Summary of Method

The method describes a technique for the simultaneous or sequential multielement determination of trace elements in solution. The basis of the method is the measurement of atomic emission by an optical spectroscopic technique. Samples are nebulized and the aerosol that is produced is transported to the plasma torch where excitation occurs. Characteristic atomic-line emission spectra are produced by a radio-frequency inductively coupled plasma (ICP). The spectra are dispersed by a grating spectrometer and the intensities of the line are monitored by photomultiplier tubes. The photocurrents from the photomultiplier tubes are processed and controlled by a computer system. A background correction technique is required to compensate for variable background contribution to the determination of trace elements. Background must be measured adjacent to analyte lines on samples during analysis. The position selected for the background intensity measurement, on either or both sides of the analytical line, will be determined by the complexity of the spectrum adjacent to the analyte line. The position used must be free of spectral interference and reflect the same change in background intensity as occurs at the analyte wavelength measured. Background

<sup>+</sup>A bibliography citing method references appears in paragraph 11 of the method.

\*CLP-M modified for the Contract Laboratory Program.



correction is not required in cases of line broadening where a background correction measurement would actually degrade the analytical result. The possibility of additional interferences named in 5.1 (and tests for their presence as described in 5.2) should also be recognized and appropriate corrections made.

### 3. Safety

The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical compound should be treated as a potential health hazard. The laboratory is responsible for maintaining a current awareness file of OSHA regulations regarding the safe handling of the chemicals specified in this method. A reference file of material handling data sheets should be made available to all personnel involved in the chemical analysis.

### 4. Interferences

4.1 Several types of interference effects may contribute to inaccuracies in the determination of trace elements. They can be summarized as follows:

4.1.1 Spectral interferences can be categorized as 1) overlap of a spectral line from another element; 2) unresolved overlap of molecular band spectra; 3) background contribution from continuous or recombination phenomena; and 4) background contribution from stray light from the line emission of high concentration elements. The first of these effects can be compensated by utilizing a computer correction of the raw data, requiring the monitoring and measurement of the interfering element. The second effect may require selection of an alternate wavelength. The third and fourth effects can usually be compensated by a background correction adjacent to the analyte line. In addition, users of simultaneous multi-element instrumentation must assume the responsibility of verifying the absence of spectral interference from an element that could occur in a sample but for which there is no channel in the instrument array.

Listed in Table 2 are some interference effects for the recommended wavelengths given in Table 1. The data in Table 2 are intended for use only as a rudimentary guide for the indication of potential spectral interferences. For this purpose, linear relations between concentration and intensity for the analytes and the interferents can be assumed. The interference information, which was collected at the Ames Laboratory<sup>\*\*</sup>, is expressed as analyte concentration equivalents (i.e., false analyte concentrations) arising from 100 mg/L of the interferent element.

The suggested use of this information is as follows: Assume that arsenic (at 193.696 nm) is to be determined in a sample containing approximately 10 mg/L of aluminum. According to Table 2, 100 mg/L of aluminum would yield a false signal for arsenic equivalent to approximately 1.3 mg/L. Therefore, 10 mg/L of aluminum would result in a false signal for arsenic equivalent to approximately 0.13 mg/L.

<sup>\*\*</sup> Ames Laboratory, USDOE, Iowa State University, Ames, Iowa 50011.



The reader is cautioned that other analytical systems may exhibit somewhat different levels of interference than those shown in Table 2, and that the interference effects must be evaluated for each individual system. Only those interferents listed were investigated and the blank spaces in Table 2 indicate that measurable interferences were not observed from the interferent concentrations listed in Table 3. Generally, interferences were discernible if they produced peaks or background shifts corresponding to 2-5% of the peaks generated by the analyte concentrations also listed in Table 3.

At present, information on the listed silver and potassium wavelengths are not available but it has been reported that second order energy from the magnesium 383.231 nm wavelength interferes with the listed potassium line at 766.491 nm.

- 4.1.2 Physical interferences are generally considered to be effects associated with the sample nebulization and transport processes. Such properties as change in viscosity and surface tension can cause significant inaccuracies especially in samples which may contain high dissolved solids and/or acid concentrations. The use of a peristaltic pump may lessen these interferences. If these types of interferences are operative, they must be reduced by dilution of the sample and/ or utilization of standard addition techniques. Another problem which can occur from high dissolved solids is salt buildup at the tip of the nebulizer. This affects aerosol flow rate causing instrumental drift.

Wetting the argon prior to nebulization, the use of a tip washer, or sample dilution have been used to control this problem. Also, it has been reported that better control of the argon flow rate improves instrument performance. This is accomplished with the use of mass flow controllers.

- 4.1.3 Chemical interferences are characterized by molecular compound formation, ionization effects and solute vaporization effects. Normally these effects are not pronounced with the ICP technique, however, if observed they can be minimized by careful selection of operating conditions (that is, incident power, observation position, and so forth), by buffering of the sample, by matrix matching, and by standard addition procedures. These types of interferences can be highly dependent on matrix type and the specific analyte element.

- 4.2 Prior to reporting concentration data for the analyte elements, the Contractor must analyze and report the results of the ICP Serial Dilution Analysis. The ICP Serial Dilution Analysis must be performed on a sample from each group of samples of a similar matrix type (i.e., water, soil) and concentration (i.e., low, medium) or for each Sample Delivery Group, whichever is more frequent. Samples identified as field blanks cannot be used for Serial Dilution Analysis.

If the analyte concentration is sufficiently high (minimally a factor of 50 above the instrumental detection limit in the original sample), the serial dilution (a five fold dilution) must then agree within 10% of the original determination after correction for dilution. If the dilution analysis for one or more analytes is not within 10%, a chemical or physical interference effect

must be suspected, and the data for all affected analytes in the samples received associated with that serial dilution must be flagged with an "E" on FORM IX-IN and FORM I-IN.

5. Apparatus

5.1 Inductively Coupled Plasma-Atomic Emission Spectrometer.

5.1.1 Computer controlled atomic emission spectrometer with background correction.

5.1.2 Radio frequency generator.

5.1.3 Argon gas supply, welding grade or better.

5.2 Operating conditions -- Because of the differences between various makes and models of satisfactory instruments, no detailed operating instructions can be provided. Instead, the analyst should follow the instructions provided by the manufacturer of the particular instrument. Sensitivity, instrumental detection limit, precision, linear dynamic range, and interference effects must be investigated and established for each individual analyte line on that particular instrument. All measurements must be within the instrument linear range where correction factors are valid. It is the responsibility of the analyst to verify that the instrument configuration and operating conditions used satisfy the analytical requirements and to maintain quality control data confirming instrument performance and analytical results.

6. Reagents and Standards

6.1 Acids used in the preparation of standards and for sample processing must be ultra-high purity grade or equivalent. Redistilled acids are acceptable.

6.1.1 Acetic acid, conc. (sp gr 1.06).

6.1.2 Hydrochloric acid, conc. (sp gr 1.19).

6.1.3 Hydrochloric acid, (1+1): Add 500 mL conc. HCl (sp gr 1.19) to 400 mL deionized, distilled water and dilute to 1 liter.

6.1.4 Nitric acid, conc. (sp gr 1.41).

6.1.5 Nitric acid, (1+1): Add 500 mL conc. HNO<sub>3</sub> (sp gr 1.41) to 400 mL deionized, distilled water and dilute to 1 liter.

6.2 Deionized, distilled water: Prepare by passing distilled water through a mixed bed of cation and anion exchange resins. Use deionized, distilled water for the preparation of all reagents, calibration standards and as dilution water. The purity of this water must be equivalent to ASTM Type II reagent water of Specification D 1193.

6.3 Standard stock solutions may be purchased or prepared from ultra high purity grade chemicals or metals. All salts must be dried for 1 hour at 105° unless otherwise specified.

(CAUTION: Many metal salts are extremely toxic and may be fatal if swallowed. Wash hands thoroughly after handling.) Typical stock solution preparation procedures follow:

- 6.3.1 Aluminum solution, stock, 1 mL = 100 ug Al: Dissolved 0.100 g of aluminum metal in an acid mixture of 4 mL of (1+1) HCl and 1 mL of conc.  $\text{HNO}_3$  in a beaker. Warm gently to effect solution. When solution is complete, transfer quantitatively to a liter flask, add an additional 10 mL of (1+1) HCl and dilute to 1000 mL with deionized, distilled water.
- 6.3.2 Antimony solution stock, 1 mL = 100 ug Sb: Dissolve 0.2669 g  $\text{K}(\text{SbO})\text{C}_4\text{H}_4\text{O}_6$  in deionized distilled water, add 10 mL (1+1) HCl and dilute to 1000 mL with deionized, distilled water.
- 6.3.3 Arsenic solution, stock, 1 mL = 100 ug As: Dissolve 0.1320 g of  $\text{As}_2\text{O}_3$  in 100 mL of deionized, distilled water containing 0.4 g NaOH. Acidify the solution with 2 mL conc.  $\text{HNO}_3$  and dilute to 1,000 mL with deionized, distilled water.
- 6.3.4 Barium solution, stock, 1 mL = 100 ug Ba: Dissolve 0.1516 g  $\text{BaCl}_2$  (dried at  $250^\circ\text{C}$  for 2 hrs) in 10 mL deionized, distilled water with 1 mL (1+1) HCl. Add 10.0 mL (1+1) HCl and dilute to 1,000 mL with deionized, distilled water.
- 6.3.5 Beryllium solution, stock, 1 mL = 100 ug Be: Do not dry. Dissolve 1.966 g  $\text{BeSO}_4 \cdot 4\text{H}_2\text{O}$ , in deionized, distilled water, add 10.0 mL conc.  $\text{HNO}_3$  and dilute to 1,000 mL with deionized, distilled water.
- 6.3.6 Boron solution, stock, 1 mL = 100 ug B: Do not dry. Dissolve 0.5716 g anhydrous  $\text{H}_3\text{BO}_3$  in deionized, distilled water and dilute to 1,000 mL. Use a reagent meeting ACS specifications, keep the bottle tightly stoppered and store in a desiccator to prevent the entrance of atmospheric moisture.
- 6.3.7 Cadmium solution, stock, 1 mL = 100 ug Cd: Dissolve 0.1142 g CdO in a minimum amount of (1+1)  $\text{HNO}_3$ . Heat to increase rate of dissolution. Add 10.0 mL conc.  $\text{HNO}_3$  and dilute to 1,000 mL with deionized, distilled water.
- 6.3.8 Calcium solution, stock, 1 mL = 100 ug Ca: Suspend 0.2498 g  $\text{CaCO}_3$  dried at  $180^\circ\text{C}$  for 1 h before weighing in deionized, distilled water and dissolve cautiously with a minimum amount of (1+1)  $\text{HNO}_3$ . Add 10.0 mL conc.  $\text{HNO}_3$  and dilute to 1,000 mL with deionized, distilled water.
- 6.3.9 Chromium solution, stock, 1 mL = 100 ug Cr: Dissolve 0.1923 g of  $\text{CrO}_3$  in deionized, distilled water. When solution is complete acidify with 10 mL conc.  $\text{HNO}_3$  and dilute to 1,000 mL with deionized, distilled water.
- 6.3.10 Cobalt solution stock, 1 mL = 100 ug Co: Dissolve 0.1000 g of cobalt metal in a minimum amount of (1+1)  $\text{HNO}_3$ . Add 10.0 mL (1+1) HCl and dilute to 1,000 mL with deionized, distilled water.



- 6.3.11 Copper solution, stock, 1 mL = 100 ug Cu: Dissolve 0.1252 g CuO in a minimum amount of (1+1) HNO<sub>3</sub>. Add 10.0 mL conc. HNO<sub>3</sub> and dilute to 1,000 mL with deionized, distilled water.
- 6.3.12 Iron solution, stock, 1 mL = 100 ug Fe: Dissolve 0.1430 g Fe<sub>2</sub>O<sub>3</sub> in a warm mixture of 20 mL (1+1) HCl and 2 mL of conc. HNO<sub>3</sub>. Cool, add an additional 5 mL of conc. HNO<sub>3</sub> and dilute to 1,000 mL with deionized, distilled water.
- 6.3.13 Lead solution, stock, 1 mL = 100 ug Pb: Dissolve 0.1599 g Pb(NO<sub>3</sub>)<sub>2</sub> in a minimum amount of (1+1) HNO<sub>3</sub>. Add 10.0 mL of conc. HNO<sub>3</sub> and dilute to 1,000 mL with deionized, distilled water.
- 6.3.14 Magnesium solution, stock, 1 mL = 100 ug Mg: Dissolve 0.1658 g MgO in a minimum amount of (1+1) HNO<sub>3</sub>. Add 10.0 mL conc. HNO<sub>3</sub> and dilute to 1,000 mL with deionized, distilled water.
- 6.3.15 Manganese solution, stock, 1 mL = 100 ug Mn: Dissolve 0.1000 g of manganese metal in the acid mixture, 10 mL conc. HCl and 1 mL conc. HNO<sub>3</sub>, and dilute to 1,000 mL with deionized, distilled water.
- 6.3.16 Molybdenum solution, stock, 1 mL = 100 ug Mo: Dissolve 0.2043 g (NH<sub>4</sub>)<sub>2</sub>MoO<sub>4</sub> in deionized, distilled water and dilute to 1,000 mL.
- 6.3.17 Nickel solution, stock, 1 mL = 100 ug Ni: Dissolve 0.1000 g of nickel metal in 10 mL hot conc. HNO<sub>3</sub>, cool and dilute to 1,000 mL with deionized, distilled water.
- 6.3.18 Potassium solution, stock, 1 mL = 100 ug K: Dissolve 0.1907 g KCl, dried at 110°C, in deionized, distilled water. Dilute to 1,000 mL.
- 6.3.19 Selenium solution, stock, 1 mL = 100 ug Se: Do not dry. Dissolve 0.1727 g H<sub>2</sub>SeO<sub>3</sub> (actual assay 94.6%) in deionized, distilled water and dilute to 1,000 mL.
- 6.3.20 Silica solution, stock, 1 mL = 100 ug SiO<sub>2</sub>: Do not dry. Dissolve 0.4730 g Na<sub>2</sub>SiO<sub>3</sub>·9H<sub>2</sub>O in deionized, distilled water. Add 10.0 mL conc. HNO<sub>3</sub> and dilute to 1,000 mL with deionized, distilled water.
- 6.3.21 Silver solution, stock, 1 mL = 100 ug Ag: Dissolve 0.1575 g AgNO<sub>3</sub> in 100 mL of deionized, distilled water and 10 mL conc. HNO<sub>3</sub>. Dilute to 1,000 mL with deionized, distilled water.
- 6.3.22 Sodium solution, stock, 1 mL = 100 ug Na: Dissolve 0.2542 g NaCl in deionized, distilled water. Add 10.0 mL conc. HNO<sub>3</sub> and dilute to 1,000 mL with deionized, distilled water.
- 6.3.23 Thallium solution, stock, 1 mL = 100 ug Tl: Dissolve 0.1303 g TlNO<sub>3</sub> in deionized, distilled water. Add 10.0 mL conc. HNO<sub>3</sub> and dilute to 1,000 mL with deionized, distilled water.



6.3.24 Vanadium solution, stock, 1 mL = 100 ug V: Dissolve 0.2297  $\text{NH}_4\text{VO}_3$  in a minimum amount of conc.  $\text{HNO}_3$ . Heat to increase rate of dissolution. Add 10.0 mL conc.  $\text{HNO}_3$  and dilute to 1,000 mL with deionized, distilled water.

6.3.25 Zinc solution, stock, 1 mL = 100 ug Zn: Dissolve 0.1245 g  $\text{ZnO}$  in a minimum amount of dilute  $\text{HNO}_3$ . Add 10.0 mL conc.  $\text{HNO}_3$  and dilute to 1,000 mL with deionized, distilled water.

6.4 Mixed calibration standard solutions -- Prepare mixed calibration standard solutions by combining appropriate volumes of the stock solutions in volumetric flasks. (See 7.4.1 thru 7.4.5.) Add 2 mL of (1+1)  $\text{HNO}_3$  and 10 mL of (1+1)  $\text{HCl}$  and dilute to 100 mL with deionized, distilled water. (See NOTE in 7.4.5) Prior to preparing the mixed standards, each stock solution should be analyzed separately to determine possible spectral interference or the presence of impurities. Care should be taken when preparing the mixed standards that the elements are compatible and stable. Transfer the mixed standard solutions to a FEP fluorocarbon or unused polyethylene bottle for storage. Fresh mixed standards should be prepared as needed with the realization that concentration can change on aging. Calibration standards must be initially verified using a quality control sample and monitored weekly for stability (see 7.6.3). Although not specifically required, some typical calibration standard combinations follow when using those specific wavelengths listed in Table 1.

6.4.1 Mixed standard solution I -- Manganese, beryllium, cadmium, lead, and zinc.

6.4.2 Mixed standard solution II -- Barium, copper, iron, vanadium, and cobalt.

6.4.3 Mixed standard solution III -- Molybdenum, silica, arsenic, and selenium.

6.4.4 Mixed standard solution IV -- Calcium, sodium, potassium, aluminum, chromium and nickel.

6.4.5 Mixed standard solution V -- Antimony, boron, magnesium, silver, and thallium.

NOTE: If the addition of silver to the recommended acid combination results in an initial precipitation add 15 mL of deionized distilled water and warm the flask until the solution clears. Cool and dilute to 100 mL with deionized, distilled water. For this acid combination the silver concentration should be limited to 2 mg/L. Silver under these conditions is stable in a tap water matrix for 30 days. Higher concentrations of silver require additional  $\text{HCl}$ .

6.5 Two types of blanks are required for the analysis. The calibration blank (3.13) is used in establishing the analytical curve while the reagent blank (preparation blank, 3.12) is used to correct for possible contamination resulting from varying amounts of the acids used in the sample processing.

- 6.5.1 The calibration blank is prepared by diluting 2 mL of (1+1) HNO<sub>3</sub> and 10 mL of (1+1) HCl to 100 mL with deionized, distilled water. Prepare a sufficient quantity to be used to flush the system between standards and samples.
- 6.5.2 The reagent blank (or preparation blank - See Exhibit E) must contain all the reagents and in the same volumes as used in the processing of the samples. The reagent blank must be carried through the complete procedure and contain the same acid concentration in the final solution as the sample solution used for analysis.
- 6.6 In addition the calibration standards, an instrument check standard (3.6), an interference check sample (3.7) and a quality control sample (3.8) are also required for the analyses.
  - 6.6.1 The instrument check standard for continuing calibration verification is prepared by the analyst by combining compatible elements at a concentration equivalent to the mid-points of their respective calibration curves. (See 10.1.3.)
  - 6.6.2 The interference check sample is prepared by the analyst, or obtained from EPA if available (Exhibit E).
  - 6.6.3 The quality control sample for the initial calibration verification should be prepared in the same acid matrix as the calibration standards and in accordance with the instructions provided by the supplier. EPA will either supply a quality control sample or information where one of equal quality can be procured. (See 10.1.1.)

#### Procedure

- 7.1 Set up instrument with proper operating parameters established in Section 6.2. The instrument must be allowed to become thermally stable before beginning. This usually requires at least 30 min. of operation prior to calibration.
- 7.2 Initiate appropriate operating configuration of computer.
- 7.3 Profile and calibrate instrument according to instrument manufacturer's recommended procedures, using mixed calibration standard solutions such as those described in Section 7.4. Flush the system with the calibration blank (7.5.1) between each standard. (NOTE: For boron concentrations greater than 500 ug/L extended flush times of 1 to 2 minutes may be required.)
- 7.4 Begin the sample run flushing the system with the calibration blank solution (7.5.1) between each sample. (See NOTE in 8.3.) Analyze the instrument check standard (7.6.1) and the calibration blank (7.5.1) each 10 analytical samples.
- 7.5 A minimum of two replicate exposures are required for standardization and all QC and sample analyses. The average result of the multiple exposures for the standardization and all QC and sample analyses shall be used.

Calculation

- .1 Reagent blanks (preparation blanks) should be treated as specified in Exhibit E.
- .2 If dilutions were performed, the appropriate factor must be applied to sample values.
- .3 Units must be clearly specified.

Quality Control (Instrumental)

- .1 Quality control must be performed as specified in Exhibit E.

TABLE 1 - RECOMMENDED WAVELENGTHS(2) AND ESTIMATED INSTRUMENTAL DETECTION LIMITS

| Element                    | Wavelength, nm(1) | Estimated Detection Limit, ug/L(2) |
|----------------------------|-------------------|------------------------------------|
| Aluminum                   | 308.215           | 45                                 |
| Antimony                   | 206.833           | 32                                 |
| Arsenic                    | 193.696           | 53                                 |
| Barium                     | 455.403           | 2                                  |
| Beryllium                  | 313.042           | 0.3                                |
| Boron                      | 249.773           | 5                                  |
| Cadmium                    | 226.502           | 4                                  |
| Calcium                    | 317.933           | 10                                 |
| Chromium                   | 267.716           | 7                                  |
| Cobalt                     | 228.616           | 7                                  |
| Copper                     | 324.754           | 6                                  |
| Iron                       | 259.940           | 7                                  |
| Lead                       | 220.353           | 42                                 |
| Magnesium                  | 279.079           | 30                                 |
| Manganese                  | 257.610           | 2                                  |
| Molybdenum                 | 202.030           | 8                                  |
| Nickel                     | 231.604           | 15                                 |
| Potassium                  | 766.491           | See(3)                             |
| Selenium                   | 196.026           | 75                                 |
| Silica (SiO <sub>2</sub> ) | 288.158           | 58                                 |
| Silver                     | 328.068           | 7                                  |
| Sodium                     | 588.995           | 29                                 |
| Thallium                   | 190.864           | 40                                 |
| Vanadium                   | 292.402           | 8                                  |
| Zinc                       | 213.856           | 2                                  |

- 1) The wavelengths listed are recommended because of their sensitivity and overall acceptance. Other wavelengths may be substituted if they can provide the needed sensitivity and are treated with the same corrective techniques for spectral interference. (See 5.1.1). The use of alternate wavelengths must be reported (in nm) with the sample data.
- 2) The estimated instrumental detection limits as shown are taken from "Inductively Coupled Plasma-Atomic Emission Spectroscopy-Prominent Lines," EPA-600/4-79-017. They are given as a guide for an instrumental limit. The actual method detection limits are sample dependent and may vary as the sample matrix varies.
- 3) Highly dependent on operating conditions and plasma position.



TABLE 2. EXAMPLE OF ANALYTE CONCENTRATION EQUIVALENTS (MG/L) ARISING FROM INTERFERENTS AT THE 100 MG/L LEVEL

| Analyte    | Wavelength,<br>nm | Interferent |      |      |      |       |       |      |      |      |      |
|------------|-------------------|-------------|------|------|------|-------|-------|------|------|------|------|
|            |                   | Al          | Ca   | Cr   | Cu   | Fe    | Mg    | Mn   | Ni   | Ti   | V    |
| Aluminum   | 308.215           | --          | --   | --   | --   | --    | --    | 0.21 | --   | --   | 1.4  |
| Antimony   | 206.833           | 0.47        | --   | 2.9  | --   | 0.08  | --    | --   | --   | .25  | 0.45 |
| Arsenic    | 193.696           | 1.3         | --   | 0.44 | --   | --    | --    | --   | --   | --   | 1.1  |
| Barium     | 455.403           | --          | --   | --   | --   | --    | --    | --   | --   | --   | --   |
| Beryllium  | 313.042           | --          | --   | --   | --   | --    | --    | --   | --   | 0.04 | 0.05 |
| Boron      | 249.773           | 0.04        | --   | --   | --   | 0.32  | --    | --   | --   | --   | --   |
| Cadmium    | 226.502           | --          | --   | --   | --   | 0.03  | --    | --   | 0.02 | --   | --   |
| Calcium    | 317.933           | --          | --   | 0.08 | --   | 0.01  | 0.01  | 0.04 | --   | 0.03 | 0.03 |
| Chromium   | 267.716           | --          | --   | --   | --   | 0.003 | --    | 0.04 | --   | --   | 0.04 |
| Cobalt     | 228.616           | --          | --   | 0.03 | --   | 0.005 | --    | --   | 0.03 | 0.15 | --   |
| Copper     | 324.754           | --          | --   | --   | --   | 0.003 | --    | --   | --   | 0.05 | 0.02 |
| Iron       | 259.940           | --          | --   | --   | --   | --    | --    | 0.12 | --   | --   | --   |
| Lead       | 220.353           | 0.17        | --   | --   | --   | --    | --    | --   | --   | --   | --   |
| Magnesium  | 279.079           | --          | 0.02 | 0.11 | --   | 0.13  | --    | 0.25 | --   | 0.07 | 0.12 |
| Manganese  | 257.610           | 0.005       | --   | 0.01 | --   | 0.002 | 0.002 | --   | --   | --   | --   |
| Molybdenum | 202.030           | 0.05        | --   | --   | --   | 0.03  | --    | --   | --   | --   | --   |
| Nickel     | 231.604           | --          | --   | --   | --   | --    | --    | --   | --   | --   | --   |
| Selenium   | 196.026           | 0.23        | --   | --   | --   | 0.09  | --    | --   | --   | --   | --   |
| Silicon    | 288.158           | --          | --   | 0.07 | --   | --    | --    | --   | --   | --   | 0.01 |
| Sodium     | 588.995           | --          | --   | --   | --   | --    | --    | --   | --   | 0.08 | --   |
| Thallium   | 190.864           | 0.30        | --   | --   | --   | --    | --    | --   | --   | --   | --   |
| Vanadium   | 292.402           | --          | --   | 0.05 | --   | 0.005 | --    | --   | --   | 0.02 | --   |
| Zinc       | 213.856           | --          | --   | --   | 0.14 | --    | --    | --   | 0.29 | --   | --   |

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Exhibit D ICP-AES

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TABLE 3. INTERFERENT AND ANALYTE ELEMENTAL CONCENTRATIONS USED  
FOR INTERFERENCE MEASUREMENTS IN TABLE 2

| Analytes | (mg/L) | Interferents | (mg/L) |
|----------|--------|--------------|--------|
| Al       | 10     | Al           | 1000   |
| As       | 10     | Ca           | 1000   |
| B        | 10     | Cr           | 200    |
| Ba       | 1      | Cu           | 200    |
| Be       | 1      | Fe           | 1000   |
| Ca       | 1      | Mg           | 1000   |
| Cd       | 10     | Mn           | 200    |
| Co       | 1      | Ni           | 200    |
| Cr       | 1      | Ti           | 200    |
| Cu       | 1      | V            | 200    |
| Fe       | 1      |              |        |
| Mg       | 1      |              |        |
| Mn       | 1      |              |        |
| Mo       | 10     |              |        |
| Na       | 10     |              |        |
| Ni       | 10     |              |        |
| Pb       | 10     |              |        |
| Sb       | 10     |              |        |
| Se       | 10     |              |        |
| Si       | 1      |              |        |
| Tl       | 10     |              |        |
| V        | 1      |              |        |
| Zn       | 10     |              |        |

PART B - ATOMIC ABSORPTION METHODS. FURNACE TECHNIQUE<sup>+</sup>

| <u>Analyte/Method</u>          | <u>Page No.</u> |
|--------------------------------|-----------------|
| Antimony - Method 204.2 CLP-M* | D-29            |
| Arsenic - Method 206.2 CLP-M   | D-30            |
| Beryllium - Method 210.2 CLP-M | D-31            |
| Cadmium - Method 213.2 CLP-M   | D-32            |
| Chromium - Method 218.2 CLP-M  | D-33            |
| Lead - Method 239.2 CLP-M      | D-34            |
| Selenium - Method 270.2 CLP-M  | D-36            |
| Silver - Method 272.2 CLP-M    | D-38            |
| Thallium - Method 279.2 CLP-M  | D-39            |

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<sup>+</sup>From "Methods for Chemical Analysis of Water and Wastes" (EPA-600/4-79-020), Metals-4, as modified for use in the Contract Laboratory Program).

\*CLP-M modified for the Contract Laboratory Program.

## ANTIMONY

## Method 204.2 CLP-M\* (Atomic Absorption, Furnace Technique)

Optimum Concentration Range: 20-300 ug/L

Approximate Detection Limit: 3 ug/L

Preparation of Standard Solution

1. Stock solution: Carefully weigh 2.7426 g of antimony potassium tartrate (analytical reagent grade) and dissolve in deionized distilled water. Dilute to 1 liter with deionized water. 1 mL = 1 mg Sb (1000 mg/L).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. These solutions are also to be used for "standard additions".
3. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrument Parameters (General)

1. Drying Time and Temp: 30 sec @ 125°C.
2. Ashing Time and Temp: 30 sec @ 800°C.
3. Atomizing Time and Temp: 10 sec @ 2700°C.
4. Purge Gas Atmosphere: Argon
5. Wavelength: 217.6 nm
6. Other operating parameters should be set as specified by the particular instrument manufacturer.

Notes

1. The above concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20 uL injection, continuous flow purge gas and non-pyrolytic graphite and are to be used as guidelines only. Smaller size furnace devices or those employing faster rates of atomization can be operated using lower atomization temperatures for shorter time periods than the above recommended settings.
2. The use of background correction is required.
3. Nitrogen may also be used as the purge gas.
4. If chloride concentration presents a matrix problem or causes a loss previous to atomization, add an excess 5 mg of ammonium nitrate to the furnace and ash using a ramp accessory or with incremental steps until the recommended ashing temperature is reached.
5. For every sample analyzed, verification is necessary to determine that method of standard addition is not required (see Exhibit E).
6. If method of standard addition is required, follow the procedure given in Exhibit E.

\*CLP-M modified for the Contract Laboratory Program.



## ARSENIC

## Method 206.2 CLP-M\* (Atomic Absorption, Furnace Technique)

Concentration Range: 5-100 ug/L  
Detection Limit: 1 ug/L

Preparation of Standard Solution

Stock solution: Dissolve 1.320 g of arsenic trioxide,  $\text{As}_2\text{O}_3$  (analytical reagent grade) in 100 mL of deionized distilled water containing 4 g NaOH. Acidify the solution with 20 mL conc.  $\text{HNO}_3$  and dilute to 1 Liter. 1 mL = 1 mg As (1000 mg/L).

Nickel Nitrate Solution, 5%: Dissolve 24.780 g of ACS reagent grade  $\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$  in deionized distilled water and make up to 100 mL.

Nickel Nitrate Solution, 1%: Dilute 20 mL of the 5% nickel nitrate to 100 mL with deionized distilled water.

Working Arsenic Solution: Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. Withdraw appropriate aliquots of the stock solution, add 1 mL of conc.  $\text{HNO}_3$ , 2 mL of 30%  $\text{H}_2\text{O}_2$  and 2 mL of the 5% nickel nitrate solution. Dilute to 100 mL with deionized distilled water.

Sample Preparation

Add 100 uL of the 5% nickel nitrate solution to 5 mL of the digested sample. The sample is now ready for injection into the furnace.

Instrument Parameters (General)

Drying Time and Temp: 30 sec @ 125°C.

Ashing Time and Temp: 30 sec @ 1100°C.

Atomizing Time and Temp: 10 sec @ 2700°C.

Purge Gas Atmosphere: Argon

Wavelength: 193.7 nm

Other operating parameters should be set as specified by the particular instrument manufacturer.

Notes

The above concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20 uL injection, purge gas interrupt and non-pyrolytic graphite. Smaller size furnace devices or those employing faster rates of atomization can be operated using lower atomization temperatures for shorter time periods than the above recommended settings.

The use of background correction is required. Background correction made by the deuterium arc method does not adequately compensate for high levels of certain interferents (ie., Al, Fe). If conditions occur where significant interference is suspected, the lab must switch to an alternate wavelength or take other appropriate actions to compensate for the interference effects.

For every sample analyzed, verification is necessary to determine that method of standard addition is not required (see Exhibit E).

If method of standard addition is required, follow the procedure given in Exhibit E).

The use of the Electrodeless Discharge Lamps (EDL) for the light source is recommended.

P-M modified for the Contract Laboratory Program.

## BERYLLIUM

## Method 210.2 CLP-M\* (Atomic Absorption, Furnace Technique)

Optimum Concentration Range: 1-30 ug/L

Approximate Detection Limit: 0.2 ug/L

Preparation of Standard Solution

1. Stock solution: Dissolve 11.6586g of beryllium sulfate,  $\text{BeSO}_4$ , in deionized distilled water containing 2 mL concentrated nitric acid and dilute to 1 Liter. 1 mL = 1 mg Be (1000 mg/L).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. These solutions are also to be used for "standard additions".
3. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrument Parameters (General)

1. Drying Time and Temp: 30 sec @ 125°C.
2. Ashing Time and Temp: 30 sec @ 1000°C.
3. Atomizing Time and Temp: 10 sec @ 2800°C.
4. Purge Gas Atmosphere: Argon
5. Wavelength: 234.9 nm
6. The operating parameters should be set as specified by the particular instrument manufacturer.

Notes

- The above concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20 uL injection, continuous flow purge gas and non-pyrolytic graphite and are to be used as guidelines only. Smaller size furnace devices or those employing faster rates of atomization can be operated using lower atomization temperatures for shorter time periods than the above recommended settings.
2. The use of background correction is required.
  3. Because of possible chemical interaction, nitrogen should not be used as a purge gas.
  4. For every sample analyzed, verification is necessary to determine that method of standard addition is not required (see Exhibit E)
  5. If method of standard addition is required, follow the procedure given in Exhibit E.

\*CLP-M modified for the Contract Laboratory Program.

## CADMIUM

## Method 213.2 CLP-M\* (Atomic Absorption, Furnace Technique)

Concentration Range: 0.5-10 ug/L

Approximate Detection Limit: 0.1 ug/L

Preparation of Standard Solution

Stock solution: Carefully weigh 2.282g of cadmium sulfate,  $3 \text{ CdSO}_4 \cdot 8 \text{ H}_2\text{O}$  (analytical reagent grade) and dissolve in deionized distilled water. Make up to 1 liter with deionized distilled water. 1 mL = 1 mg Cd (1000 mg/L).

Ammonium Phosphate solution (40%): Dissolve 40 grams of ammonium phosphate,  $(\text{NH}_4)_2\text{HPO}_4$  (analytical reagent grade) in deionized distilled water and dilute to 100 mL.

Prepare dilutions of stock cadmium solution to be used as calibration standards at the time of analysis. To each 100 mL of standard and sample alike add 2.0 mL of the ammonium phosphate solution. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrument Parameters (General)

Drying Time and Temp: 30 sec @ 125°C.

Ashing Time and Temp: 30 sec @ 500°C.

Atomizing Time and Temp: 10 sec @ 1900°C.

Purge Gas Atmosphere: Argon

Wavelength: 228.8 nm

The operating parameters should be set as specified by the particular instrument manufacturer.

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The above concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20 uL injection, continuous flow purge gas and non-pyrolytic graphite and are to be used as guidelines only. Smaller size furnace devices or those employing faster rates of atomization can be operated using lower atomization temperatures for shorter time periods than the above recommended settings.

The use of background correction is required.

Contamination from the work area is critical in cadmium analysis. Use pipette tips which are free of cadmium.

For every sample analyzed, verification is necessary to determine that method of standard addition is not required (see Exhibit E).

If method of standard addition is required, follow the procedure given in Exhibit E.

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\*M modified for the Contract Laboratory Program.

## CHROMIUM

## Method 218.2 CLP-M\* (Atomic Absorption, Furnace Technique)

Optimum Concentration Range: 5-100 ug/L

Approximate Detection Limit: 1 ug/L

Preparation of Standard Solution

1. Stock solution: Prepare as described under Part C methods, AA Flame Technique.
2. Calcium Nitrate solution: Dissolve 11.8 grams of calcium nitrate,  $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$  (analytical reagent grade) in deionized distilled water and dilute to 100 mL. 1 mL = 20 mg Ca.
3. Prepare dilutions of the stock chromium solution to be used as calibration standards at the time of analysis. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation. To each 100 mL of standard and sample alike, add 1 mL of 30%  $\text{H}_2\text{O}_2$  and 1 mL of the calcium nitrate solution.

Instrument Parameters (General)

1. Drying Time and Temp: 30 sec @ 125°C.
2. Ashing Time and Temp: 30 sec @ 1000°C.
3. Atomizing Time and Temp: 10 sec @ 2700°C.
4. Purge Gas Atmosphere: Argon
5. Wavelength: 357.9 nm
6. Other operating parameters should be set as specified by the particular instrument manufacturer.

Notes

1. The above concentration values and instrument conditions are for a Perkin Elmer HGA-2100, based on the use of a 20 uL injection, continuous flow purge gas and non-pyrolytic graphite and are to be used as guidelines only.
2. Hydrogen peroxide is added to the acidified solution to convert all chromium to the trivalent state. Calcium is added to a level above 200 mg/L where its suppressive effect becomes constant up to 1000 mg/L.
3. Background correction is required.
4. Nitrogen should not be used as a purge gas because of possible CN band interference.
5. Pipette tips have been reported to be a possible source of contamination.
6. For every sample analyzed, verification is necessary to determine that method of standard addition is not required (see Exhibit E).
7. If method of standard addition is required, follow the procedure given in Exhibit E.

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\*CLP-M modified for the Contract Laboratory Program.



## LEAD

## Method 239.2 CLP-M\* (Atomic Absorption, Furnace Technique)

Optimum Concentration Range: 5-100 ug/L

Approximate Detection Limit: 1 ug/L

Preparation of Standard Solution

1. Stock solution: Carefully weigh 1.599 g of lead nitrate,  $\text{Pb}(\text{NO}_3)_2$  (analytical reagent grade), and dissolve in deionized distilled water. When solution is complete, acidify with 10 mL redistilled  $\text{HNO}_3$  and dilute to 1 Liter with deionized distilled water. 1 mL = 1 mg Pb (1000mg/L).
2. Lanthanum Nitrate solution: Dissolve 58.64 g of ACS reagent grade  $\text{La}_2\text{O}_3$  in 100 mL conc.  $\text{HNO}_3$  and dilute to 1000 mL with deionized distilled water. 1 mL = 50 mg La.
3. Working Lead solution: Prepare dilutions of stock lead solution to be used as calibration standards at the time of analysis. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation. To each 100 mL of diluted standard add 10 mL of the lanthanum nitrate solution.

Sample Preparation

1. To each 100 mL of prepared sample solution add 10 mL of the lanthanum nitrate solution.

Instrument Parameters (General)

1. Drying Time and Temp: 30 sec @ 125°C.
2. Ashing Time and Temp: 30 sec @ 500°C.
3. Atomizing Time and Temp: 10 sec @ 2700°C.
4. Purge Gas Atmosphere: Argon
5. Wavelength: 283.3 nm
6. Other operating parameters should be set as specified by the particular instrument manufacturer.

Notes

1. The above concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20 uL injection, continuous flow purge gas and non-pyrolytic graphite and are to be used as guidelines only. Smaller size furnace devices or those employing faster rates of atomization can be operated using lower atomization temperatures for shorter time periods than the above recommended settings.
2. The use of background correction is required.

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\*CLP-M modified for the Contract Laboratory Program.

3. Greater sensitivity can be achieved using the 217.0 nm line, but the optimum concentration range is reduced. The use of a lead electrodeless discharge lamp at this lower wavelength has been found to be advantageous. Also a lower atomization temperature (2400°C) may be preferred.
4. To suppress sulfate interference (up to 1500 ppm) lanthanum is added as the nitrate to both samples and calibration standards. (Atomic Absorption Newsletter Vol. 15, No. 3, p. 71, May-June 1976).
5. Since glassware contamination is a severe problem in lead analysis, all glassware should be cleaned immediately prior to use, and once cleaned, should not be open to the atmosphere except when necessary.
6. For every sample analyzed, verification is necessary to determine that method of standard addition is not required (see Exhibit E).
7. If method of standard addition is required, follow the procedure given in Exhibit E.

## SELENIUM

## Method 270.2 CLP-M\* (Atomic Absorption, Furnace Technique)

Optimum Concentration Range: 5-100 ug/L

Approximate Detection Limit: 2 ug/L

Preparation of Standard Solution

1. Stock Selenium solution: Dissolve 0.3453 g of selenous acid (actual assay 94.6%  $\text{H}_2\text{SeO}_3$ ) in deionized distilled water and make up to 200 mL. 1 mL = 1 mg Se (1000 mg/L).
2. Nickel Nitrate solution, 5%: Dissolve 24.780 g of ACS reagent grade  $\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$  in deionized distilled water and make up to 100 mL.
3. Nickel Nitrate solution, 1%: Dilute 20 mL of the 5% nickel nitrate to 100 mL with deionized distilled water.
4. Working Selenium solution: Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation. Withdraw appropriate aliquots of the stock solution, add 1 mL of conc.  $\text{HNO}_3$ , 2 mL of 30%  $\text{H}_2\text{O}_2$  and 2 mL of the 5% nickel nitrate solution. Dilute to 100 mL with deionized distilled water.

Sample Preparation

1. Add 100 uL of the 5% nickel nitrate solution to 5 mL of the digested sample. The sample is now ready for injection into the furnace.

Instrument Parameters

1. Drying Time and Temp: 30 sec @  $125^\circ\text{C}$ .
2. Charring Time and Temp: 30 sec @  $1200^\circ\text{C}$ .
3. Atomizing Time and Temp: 10 sec @  $2700^\circ\text{C}$ .
4. Purge Gas Atmosphere: Argon
5. Wavelength: 196.0 nm
6. Other operating parameters should be set as specified by the particular instrument manufacturer.

Notes

1. The above concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20 uL injection, purge gas interrupt and non-pyrolytic graphite and are to be used as guidelines only. Smaller size furnace devices or those employing faster rates of atomization can be operated using lower atomization temperatures for shorter time periods than the above recommended settings.
2. The use of background correction is required. Background correction made by the deuterium arc method does not adequately compensate for high levels of certain interferents (i.e., Al, Fe).

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\*CLP-M modified for the Contract Laboratory Program.

If conditions occur where significant interference is suspected, the lab must switch to an alternate wavelength or take other appropriate actions to compensate for the interference effects.

3. Selenium analysis suffers interference from chlorides (>800 mg/L) and sulfate (>200 mg/L). For the analysis of industrial effluents and samples with concentrations of sulfate from 200 to 2000 mg/L, both samples and standards should be prepared to contain 1% nickel.
4. For every sample analyzed, verification is necessary to determine that method of standard addition is not required (see Exhibit E).
5. If method of standard addition is required, follow the procedure given in Exhibit E.
6. The use of the Electrodeless Discharge Lamp (EDL) for the light source is recommended.



## SILVER

## Method 272.2 CLP-M\* (Atomic Absorption, Furnace Technique)

Optimum Concentration Range: 1-25 ug/L

Approximate Detection Limit: 0.2 ug/L

Preparation of Standard Solution

1. Stock solution: Dissolve 1.575 g of  $\text{AgNO}_3$  (analytical reagent grade) in deionized distilled water. Add 10 mL of concentrated  $\text{HNO}_3$  and make up to 1 Liter. 1 mL = 1 mg Ag (1000 mg/L).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. These solutions are also to be used for "standard additions".
3. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrument Parameters (General)

1. Drying Time and Temp: 30 sec @ 125°C.
2. Ashing Time and Temp: 30 sec @ 400°C.
3. Atomizing Time and Temp: 10 sec @ 2700°C.
4. Purge Gas Atmosphere: Argon
5. Wavelength: 328.1 nm
6. Other operating parameters should be set as specified by the particular instrument manufacturer.

Notes

1. The above concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20 uL injection, continuous flow purge gas and non-pyrolytic graphite and are to be used as guidelines only. Smaller size furnace devices or those employing faster rates of atomization can be operated using lower atomization temperatures for shorter time periods than the above recommended settings.
2. The use of background correction is required.
3. The use of halide acids should be avoided.
4. If absorption to container walls or formation of  $\text{AgCl}$  is suspected, see Part G, AA methods Flame Technique.
5. For every sample analyzed, verification is necessary to determine that method of standard addition is not required (see Exhibit E).
6. If method of standard addition is required, follow the procedure given in Exhibit E.

\*CLP-M modified for the Contract Laboratory Program.

## THALLIUM

## Method 279.2 CLP-M\* (Atomic Absorption, Furnace Technique)

Optimum Concentration Range: 5-100 ug/L  
Approximate Detection Limit: 1 ug/L

Preparation of Standard Solution

1. Stock solution: Dissolve 1.303g of thallium nitrate,  $TlNO_3$  (analytical reagent grade) in deionized distilled water. Add 10 mL of concentrated nitric acid and dilute to 1 Liter with deionized distilled water. 1 mL = 1 mg Tl (1000 mg/L).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. These solutions are also to be used for "standard additions".
3. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrument Parameters (General)

1. Drying Time and Temp: 30 sec @ 125°C.
2. Ashing Time and Temp: 30 sec @ 400°C.
3. Atomizing Time and Temp: 10 sec @ 2400°C.
4. Purge Gas Atmosphere: Argon
5. Wavelength: 276.8 nm
6. Other operating parameters should be set as specified by the particular instrument manufacturer.

Notes

The above concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20 uL injection, continuous flow purge gas and non-pyrolytic graphite and are to be used as guidelines only. Smaller size furnace devices or those employing faster rates of atomization can be operated using lower atomization temperatures for shorter time periods than the above recommended settings.

2. The use of background correction is required.
3. Nitrogen may also be used as the purge gas.
4. For every sample analyzed, verification is necessary to determine that method of standard addition is not required (see Exhibit E).
5. If method of standard addition is required, follow the procedure given in Exhibit E.

\*CLP-M modified for the Contract Laboratory Program.

PART C - ATOMIC ABSORPTION METHODS, FLAME TECHNIQUE<sup>+</sup>

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| Magnesium - Method 242.1 CLP-M | D-42            |
| Potassium - Method 258.1 CLP-M | D-43            |
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<sup>+</sup>From "Interim Methods for the Sampling and Analysis of Priority Pollutants in Sediments and Fish Tissue", USEPA EMSL, Cincinnati, Ohio, August 1977, Revised October 1980, as modified for use in the Contract Laboratory Program.

\*CLP-M modified for the Contract Laboratory Program.

## CALCIUM

## Method 215.1 CLP-M\* (Atomic Absorption, Flame Technique)

Optimum Concentration Range: 0.2-7 mg/L using a wavelength of 422.7 nm

Sensitivity: 0.08 mg/L

Detection Limit: 0.01 mg/L

Preparation of Standard Solution

1. Stock Solution: Suspend 1.250 g of  $\text{CaCO}_3$  (analytical reagent grade), dried at  $180^\circ\text{C}$  for 1 hour before weighing, in deionized distilled water and dissolve cautiously with a minimum of dilute HCl. Dilute to 1000 mL with deionized distilled water. 1 mL = 0.5 mg Ca (500 mg/L).
2. Lanthanum chloride solution: Dissolve 29 g of  $\text{La}_2\text{O}_3$ , slowly and in small portions, in 250 mL conc. HCl (Caution: Reaction is violent) and dilute to 500 mL with deionized distilled water.
3. Prepare dilutions of the stock calcium solutions to be used as calibration standards at the time of analysis. To each 10 mL of calibration standard and sample alike add 1.0 mL of the lanthanum chloride solution, i.e., 20 mL of standard or sample + 2 mL  $\text{LaCl}_3$  = 22 mL.

Instrumental Parameters (General)

1. Calcium hollow cathode lamp
2. Wavelength: 422.7 nm
3. Fuel: Acetylene
4. Oxidant: Air
5. Type of flame: Reducing

1. Phosphate, sulfate and aluminum interfere but are masked by the addition of lanthanum. Because low calcium values result if the pH of the sample is above 7, both standards and samples are prepared in dilute hydrochloric acid solution. Concentrations of magnesium greater than 1000 mg/L also cause low calcium values. Concentrations of up to 500 mg/L each of sodium, potassium and nitrate cause no interference.
2. Anionic chemical interferences can be expected if lanthanum is not used in samples and standards.
3. The nitrous oxide-acetylene flame will provide two to five times greater sensitivity and freedom from chemical interferences. Ionization interferences should be controlled by adding a large amount of alkali to the sample and standards. The analysis appears to be free from chemical suppressions in the nitrous oxide-acetylene flame. (Atomic Absorption Newsletter 14, 29 [1975]).
4. The 239.9 nm line may also be used. This line has a relative sensitivity of 120.

CLP-M modified for the Contract Laboratory Program.



## MAGNESIUM

## Method 242.1 CLP-M\* (Atomic Absorption, Flame Technique)

Optimum Concentration Range: 0.02-0.5 mg/L using a wavelength of 285.2 nm

Sensitivity: 0.007 mg/L

Detection Limit: 0.001 mg/L

Preparation of Standard Solution

1. Stock Solution: Dissolve 0.829 g of magnesium oxide, MgO (analytical reagent grade), in 10 mL of redistilled HNO<sub>3</sub> and dilute to 1 liter with deionized distilled water. 1 mL = 0.50 mg Mg (500 mg/L).
2. Lanthanum chloride solution: Dissolve 29 g of La<sub>2</sub>O<sub>3</sub>, slowly and in small portions in 250 mL concentrated HCl (Caution: Reaction is violent), and dilute to 500 mL with deionized distilled water.
3. Prepare dilutions of the stock magnesium solution to be used as calibration standards at the time of analysis. To each 10 mL volume of calibration standard and sample alike add 1.0 mL of the lanthanum chloride solution, i.e., 20 mL of standard or sample + 2 mL LaCl<sub>3</sub> = 22 mL.

Instrumental Parameters (General)

1. Magnesium hollow cathode lamp
2. Wavelength: 285.2 nm
3. Fuel: Acetylene
4. Oxidant: Air
5. Type of flame: Oxidizing

Notes

1. The interference caused by aluminum at concentrations greater than 2 mg/L is masked by addition of lanthanum. Sodium, potassium and calcium cause no interference at concentrations less than 400 mg/L.
2. The following line may also be used: 202.5 nm Relative Sensitivity 25.
3. To cover the range of magnesium values normally observed in surface waters (0.1-20 mg/L), it is suggested that either the 202.5 nm line be used or the burner head be rotated. A 90° rotation of the burner head will produce approximately one-eighth the normal sensitivity.

\*CLP-M modified for the Contract Laboratory Program.

## POTASSIUM

## Method 258.1 CLP-M\* (Atomic Absorption, Flame Technique)

Optimum Concentration Range: 0.1-2 mg/L using a wavelength of 766.5 nm

Sensitivity: 0.04 mg/L

Detection Limit: 0.01 mg/L

Preparation of Standard Solution

1. Stock Solution: Dissolve 0.1907 g of KCl (analytical reagent grade), dried at 110°C, in deionized distilled water and make up to 1 liter. 1 mL = 0.10 mg K (100 mg/L).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. The calibration standards should be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed either directly or after processing.

Instrumental Parameters (General)

1. Potassium hollow cathode lamp
2. Wavelength: 766.5 nm
3. Fuel: Acetylene
4. Oxidant: Air
5. Type of flame: Slightly oxidizing

Notes

1. In air-acetylene or other high temperature flames (>2800°C), potassium can experience partial ionization which indirectly affects absorption sensitivity. The presence of other alkali salts in the sample can reduce this ionization and thereby enhance analytical results. The ionization suppressive effect of sodium is small if the ratio of Na to K is under 10. Any enhancement due to sodium can be stabilized by adding excess sodium (1000 ug/mL) to both sample and standard solutions. If more stringent control of ionization is required, the addition of cesium should be considered. Reagent blanks must be analyzed to correct for potassium impurities in the buffer zone.
2. The 404.4 nm line may also be used. This line has a relative sensitivity of 500.
3. To cover the range of potassium values normally observed in surface waters (0.1-20 mg/L), it is suggested that the burner head be rotated. A 90° rotation of the burner head provides approximately one-eighth the normal sensitivity.

\*CLP-M modified for the Contract Laboratory Program.

## SODIUM

## Method 273.1 CLP-M\* (Atomic Absorption, Flame Technique)

Optimum Concentration Range: 0.03-1 mg/L using a wavelength of 589.6 nm

Sensitivity: 0.015 mg/L

Detection Limit: 0.002 mg/L

Preparation of Standard Solutions

1. Stock Solution: Dissolve 2.542 g of NaCl (analytical reagent grade), dried at 140°C, in deionized distilled water and make up to 1 liter. 1 mL = 1 mg Na (1000 mg/L).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. The calibration standards should be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed either directly or after processing.

Instrumental Parameters (General)

1. Sodium hollow cathode lamp
2. Wavelength: 589.6 nm
3. Fuel: Acetylene
4. Oxidant: Air
5. Type of flame: Oxidizing

Notes

1. The 330.2 nm resonance line of sodium, which has a relative sensitivity of 185, provides a convenient way to avoid the need to dilute more concentrated solutions of sodium.
2. Low-temperature flames increase sensitivity by reducing the extent of ionization of this easily ionized metal. Ionization may also be controlled by adding potassium (1000 mg/L) to both standards and samples.

\*CLP-M modified for the Contract Laboratory Program.

PART D - COLD VAPOR METHODS FOR MERCURY ANALYSIS

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| rcury Analysis in Water by Automated Cold Vapor Technique<br>thod 245.2 CLP-M      | D-52            |
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P-M modified for the Contract Laboratory Program.





MERCURY ANALYSIS IN WATER BY MANUAL COLD VAPOR TECHNIQUE

## MERCURY

## Method 245.1 CLP-M\* (Manual Cold Vapor Technique)

1. Scope and Application

- 1.1 In addition to inorganic forms of mercury, organic mercurials may also be present. These organo-mercury compounds will not respond to the cold vapor atomic absorption technique unless they are first broken down and converted to mercuric ions. Potassium permanganate oxidizes many of these compounds, but recent studies have shown that a number of organic mercurials, including phenyl mercuric acetate and methyl mercuric chloride, are only partially oxidized by this reagent. Potassium persulfate has been found to give approximately 100% recovery when used as the oxidant with these compounds. Therefore, a persulfate oxidation step following the addition of the permanganate has been included to insure that organo-mercury compounds, if present, will be oxidized to the mercuric ion before measurement. A heat step is required for methyl mercuric chloride when present in or spiked to a natural system.
- 1.2 The range of the method may be varied through instrument and/or recorder expansion. Using a 100 mL sample, a detection limit of 0.2 ug Hg/L can be achieved (See 10.2).

2. Summary of Method

- 2.1 The flameless AA procedure is a physical method based on the absorption of radiation at 253.7 nm by mercury vapor. Organic mercury compounds are oxidized and the mercury is reduced to the elemental state and aerated from solution in a closed system. The mercury vapor passes through a cell positioned in the light path of an atomic absorption spectrophotometer. Absorbance (peak height) is measured as a function of mercury concentration and recorded in the usual manner.

3. Sample Handling and Preservation

- 3.1 Until more conclusive data are obtained, samples are preserved by acidification with nitric acid to a pH of 2 or lower immediately at the time of collection (Exhibit D, Section II).

4. Interference

- 4.1 Possible interference from sulfide is eliminated by the addition of potassium permanganate. Concentrations as high as 20 mg/l of sulfide as sodium sulfide do not interfere with the recovery of added inorganic mercury from distilled water (Exhibit D, Section II).
- 4.2 Copper has also been reported to interfere; however, copper concentrations as high as 10 mg/L had no effect on recovery of mercury from spiked samples.

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\*CLP-M modified for the Contract Laboratory Program.

- 4.3 Sea waters, brines and industrial effluents high in chlorides require additional permanganate (as much as 25 mL). During the oxidation step, chlorides are converted to free chlorine which will also absorb radiation of 253 nm. Care must be taken to assure that free chlorine is absent before the mercury is reduced and swept into the cell. This may be accomplished by using an excess of hydroxylamine sulfate reagent (25 mL). Both inorganic and organic mercury spikes have been quantitatively recovered from the sea water using this technique.

5. Apparatus

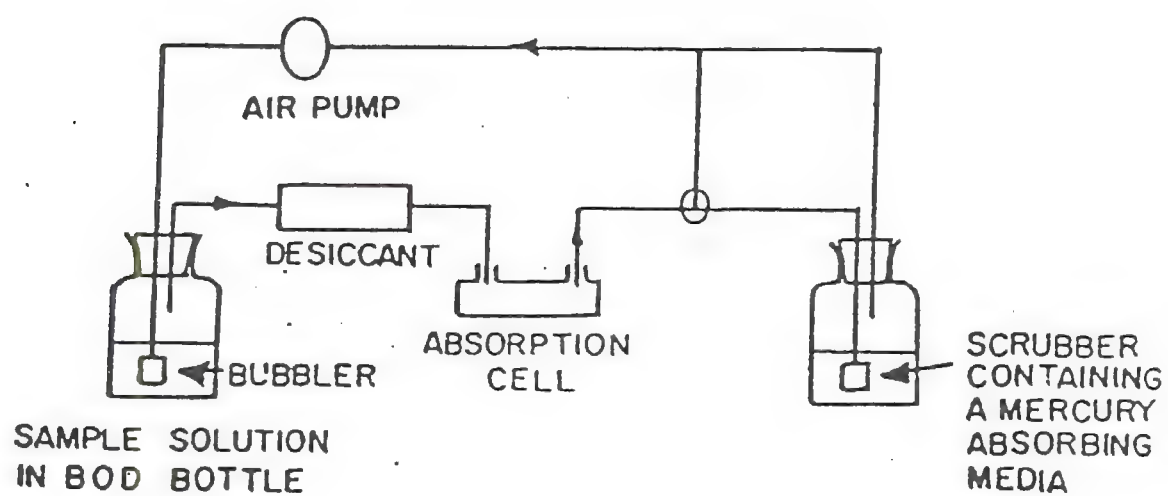
- 5.1 Atomic Absorption Spectrophotometer: (See Note 1) Any atomic absorption unit having an open sample presentation area in which to mount the absorption cell is suitable. Instrument settings recommended by the particular manufacturer should be followed.

NOTE 1: Instruments designed specifically for the measurement of mercury using the cold vapor technique are commercially available and may be substituted for the atomic absorption spectrophotometer.

- 5.2 Mercury Hollow Cathode Lamp: Westinghouse WL-22847, argon filled, or equivalent.
- 5.3 Recorder: Any multi-range variable speed recorder that is compatible with the UV detection system is suitable.
- 5.4 Absorption Cell: Standard spectrophotometer cells 10 cm long, having quartz end windows may be used. Suitable cells may be constructed from plexiglass tubing, 1" O.D. X 4-1/2". The ends are ground perpendicular to the longitudinal axis and quartz windows (1" diameter X 1/16" thickness) are cemented in place.
- The cell is strapped to a burner for support and aligned in the light beam by use of two 2" by 2" cards. One inch diameter holes are cut in the middle of each card; the cards are then placed over each end of the cell. The cell is then positioned and adjusted vertically and horizontally to find the maximum transmittance.
- 5.5 Air Pump: Any peristaltic pump capable of delivering 1 liter of air per minute may be used. A Masterflex pump with electronic speed control has been found to be satisfactory.
- 5.6 Flowmeter: Capable of measuring an air flow of 1 liter per minute.
- 5.7 Aeration Tubing: A straight glass frit having a coarse porosity. Tygon tubing is used for passage of the mercury vapor from the sample bottle to the absorption cell and return.
- 5.8 Drying Tube: 6" X 3/4" diameter tube containing 20 g of magnesium perchlorate (see Note 2). The apparatus is assembled as shown in Figure 1.

NOTE 2: In place of the magnesium perchlorate drying tube, a small reading lamp with 60W bulb may be used to prevent condensation of moisture inside the cell. The lamp is positioned to shine on the absorption cell maintaining the air temperature in the cell about 10°C above ambient.

Figure 1. Apparatus for Flameless Mercury Determination





## 6. Reagents

### 6.1 Sulfuric Acid, Conc: Reagent grade.

6.1.1 Sulfuric acid, 0.5 N: Dilute 14.0 mL of conc. sulfuric acid to 1.0 liter.

### 6.2 Nitric Acid, Conc: Reagent grade of low mercury content (see Note 3).

NOTE 3: If a high reagent blank is obtained, it may be necessary to distill the nitric acid.

### 6.3 Stannous Sulfate: Add 25 g stannous sulfate to 250 mL of 0.5 N sulfuric acid. This mixture is a suspension and should be stirred continuously during use. (Stannous chloride may be used in place of stannous sulfate.)

### 6.4 Sodium Chloride-Hydroxylamine Sulfate Solution: Dissolve 12 g of sodium chloride and 12 g of hydroxylamine sulfate in distilled water and dilute to 100 mL. (Hydroxylamine hydrochloride may be used in place of hydroxylamine sulfate.)

### 6.5 Potassium Permanganate: 5% solution, w/v. Dissolve 5 g of potassium permanganate in 100 mL of distilled water.

### 6.6 Potassium Persulfate: 5% solution, w/v. Dissolve 5 g of potassium persulfate in 100 mL of distilled water.

### 6.7 Stock Mercury Solution: Dissolve 0.1354 g of mercuric chloride in 75 mL of distilled water. Add 10 mL of conc. nitric acid and adjust the volume to 100.0 mL. 1 mL = 1 mg Hg.

### 6.8 Working Mercury Solution: Make successive dilutions of the stock mercury solution to obtain a working standard containing 0.1 ug per mL. This working standard and the dilutions of the stock mercury solution should be prepared fresh daily. Acidity of the working standard should be maintained at 0.15% nitric acid. This acid should be added to the flask as needed before the addition of the aliquot.

## 7. Calibration

### 7.1 Transfer 0, 0.5, 1.0, 5.0 and 10.0 mL aliquots of the working mercury solution containing 0 to 1.0 ug of mercury to a series of 300 mL BOD bottles. Add enough distilled water to each bottle to make a total volume of 100 mL. Mix thoroughly and add 5 mL of conc. sulfuric acid (6.1) and 2.5 mL of conc. nitric acid (6.2) to each bottle. Add 15 mL of $\text{KMnO}_4$ (6.5) solution to each bottle and allow to stand at least 15 minutes. Add 8 mL of potassium persulfate (6.6) to each bottle and heat for 2 hours in a water bath maintained at 95°C. Alternatively, cover the BOD bottles with foil and heat in an autoclave for 15 minutes at 120°C and 15 lbs. Cool and add 6 mL of sodium chloride-hydroxylamine sulfate solution (6.4) to reduce the excess permanganate. When the solution has been decolorized wait 30 seconds, add 5 mL of the stannous sulfate solution (6.3) and immediately attach the bottle to the aeration apparatus forming a closed system. At this point the sample is allowed to stand quietly without manual agitation.

The circulating pump, which has previously been adjusted to a rate of 1 liter per minute, is allowed to run continuously (see Note 4). The absorbance will increase and reach maximum within 30 seconds. As soon as the recorder pen levels off, approximately 1 minute, open the bypass valve and continue the aeration until the absorbance returns to its minimum value (see Note 5). Close the bypass valve, remove the stopper and frit from the BOD bottle and continue the aeration. Proceed with the standards and construct a standard curve by plotting peak height versus micrograms of mercury.

NOTE 4: An open system where the mercury vapor is passed through the absorption cell only once may be used instead of the closed system.

NOTE 5: Because of the toxic nature of mercury vapor precaution must be taken to avoid its inhalation. Therefore, a bypass has been included in the system to either vent the mercury vapor into an exhaust hood or pass the vapor through some absorbing media, such as: a) equal volumes of 0.1 M  $\text{KMnO}_4$ , and 10%  $\text{H}_2\text{SO}_4$  or b) 0.25% iodine in a 3% KI solution. A specially treated charcoal that will adsorb mercury vapor is available.

## 8. Procedure

- 8.1 Transfer 100 mL, or an aliquot diluted to 100 mL, containing not more than 1.0 ug of mercury, to a 300 mL BOD bottle. Add 5 mL of sulfuric acid (6.1) and 2.5 mL of conc. nitric acid (6.2) mixing after each addition. Add 15 mL of potassium permanganate solution (6.5) to each sample bottle (see Note 6). For sewage samples additional permanganate may be required. Shake and add additional portions of potassium permanganate solution, if necessary, until the purple color persists for at least 15 minutes. Add 8 mL of potassium persulfate (6.6) to each bottle and heat for 2 hours in a water bath at 95°C.

NOTE 6: The same amount of  $\text{KMnO}_4$  added to the samples should be present in standards and blanks.

Cool and add 6 mL of sodium chloride-hydroxylamine sulfate (6.4) to reduce the excess permanganate (see Note 7). Purge the head space in the BOD bottle for at least 1 minute and add 5 mL of Stannous Sulfate (6.3) and immediately attach the bottle to the aeration apparatus. Continue as described under Calibration.

NOTE 7: Add reductant in 6 mL increments until  $\text{KMnO}_4$  is completely reduced.

## 9. Calculation

- 9.1 Determine the peak height of the unknown from the chart and read the mercury value from the standard curve.
- 9.2 Calculate the mercury concentration in the sample by the formula:

$$\text{ug Hg/L} = \frac{\text{ug Hg in aliquot} \times 1,000}{\text{volume of aliquot in mL}}$$

1. Appendix

- 1.1 If additional sensitivity is required, a 200 mL sample with recorder expansion may be used provided the instrument does not produce undue noise. Using a Coleman MAS-50 with a drying tube of magnesium perchlorate and a variable recorder, 2 mv was set to read full scale. With these conditions, and distilled water solutions of mercuric chloride at concentrations of 0.15, 0.10, 0.05 and 0.025 ug/L the standard deviations were  $\pm 0.027$ ,  $\pm 0.0006$ ,  $\pm 0.01$  and  $\pm 0.004$ . Percent recoveries at these levels were 107, 83, 84 and 96%, respectively.
- 1.2 Directions for the disposal of mercury-containing wastes are given in ASTM Standards, Part 31, "Water", p. 349, Method D3223 (1976).

MERCURY ANALYSIS IN WATER BY AUTOMATED COLD VAPOR TECHNIQUEMERCURY

## Method 245.2 CLP-M\* (Automated Cold Vapor Technique)

Scope and Application

- 1 The working range is 0.2 to 20.0 ug Hg/L.

Summary of Method

- 1 The flameless AA procedure is a physical method based on the absorption of radiation at 253.7 nm by mercury vapor. The mercury is reduced to the elemental state and aerated from solution. The mercury vapor passes through a cell positioned in the light path of an atomic absorption spectrophotometer. Absorbance (peak height) is measured as a function of mercury concentration and recorded in the usual manner.
- 2 In addition to inorganic forms of mercury, organic mercurials may also be present. These organo-mercury compounds will not respond to the flameless atomic absorption technique unless they are first broken down and converted to mercuric ions. Potassium permanganate oxidizes many of these compounds, but recent studies have shown that a number of organic mercurials, including phenyl mercuric acetate and methyl mercuric chloride, are only partially oxidized by this reagent. Potassium persulfate has been found to give approximately 100% recovery when used as the oxidant with these compounds. Therefore, an automated persulfate oxidation step following the automated addition of the permanganate has been included to insure that organo-mercury compounds, if present, will be oxidized to the mercuric ion before measurement.

Sample Handling and Preservation

Until more conclusive data are obtained, samples are preserved by acidification with nitric acid to a pH of 2 or lower immediately at the time of collection (Exhibit D, Section II).

Interferences (see NOTE 1)

Some sea waters and waste-waters high in chlorides have shown a positive interference, probably due to the formation of free chlorine.

Formation of a heavy precipitate, in some wastewaters and effluents, has been reported upon addition of concentrated sulfuric acid. If this is encountered, the problem sample cannot be analyzed by this method.

Samples containing solids must be blended and then mixed while being sampled if total mercury values are to be reported.

NOTE 1: All of the above interferences can be overcome by use of the Manual Mercury method.

P-M modified for the Contract Laboratory Program.



## 5. Apparatus

- 5.1 Technicon Auto Analyzer or equivalent instrumentation consisting of:
- 5.1.1 Sampler II with provision for sample mixing.
  - 5.1.2 Manifold.
  - 5.1.3 Proportioning Pump II or III.
  - 5.1.4 High temperature heating bath with two distillation coils (Technicon Part #116-0163) in series.

5.2 Vapor-liquid separator (Figure 1).

5.3 Absorption cell, 100 mm long, 10 mm diameter with quartz windows.

5.4 Atomic Absorption Spectrophotometer (see Note 2): Any atomic absorption unit having an open sample presentation area in which to mount the absorption cell is suitable. Instrument settings recommended by the particular manufacturer should be followed.

NOTE 2: Instruments designed specifically for the measurement of mercury using the cold vapor technique are commercially available and may be substituted for the atomic absorption spectrophotometer.

5.5 Mercury Hollow Cathode Lamp: Westinghouse WL-22847, argon filled, or equivalent.

5.6 Recorder: Any multi-range variable speed recorder that is compatible with the UV detection system is suitable.

## 6. Reagents

6.1 Sulfuric Acid, Conc: Reagent grade

6.1.1 Sulfuric acid, 2 N: Dilute 56 mL of conc. sulfuric acid to 1 liter with distilled water.

6.1.2 Sulfuric acid, 10%: Dilute 100 mL conc. sulfuric acid to 1 liter with distilled water.

6.2 Nitric acid, Conc: Reagent grade of low mercury content.

6.2.1. Nitric Acid, 0.5% Wash Solution: Dilute 5 mL of concentrated nitric acid to 1 liter with distilled water.

6.3 Stannous Sulfate (See Note 3): Add 50 g stannous sulfate to 500 mL of 2 N sulfuric acid (6.1.1). This mixture is a suspension and should be stirred continuously during use.

NOTE 3: Stannous chloride may be used in place of stannous sulfate.

- 6.4 Sodium Chloride-Hydroxylamine Sulfate (See Note 4) Solution: Dissolve 30 g of sodium chloride and 30 g of hydroxylamine sulfate in distilled water to 1 liter.

NOTE 4: Hydroxylamine hydrochloride may be used in place of hydroxylamine sulfate.

- 6.5 Potassium Permanganate: 0.5% solution, w/v. Dissolve 5 g of potassium permanganate in 1 liter of distilled water.
- 6.6 Potassium Permanganate, 0.1 N: Dissolve 3.16 g of potassium permanganate in distilled water and dilute to 1 liter.
- 6.7 Potassium Persulfate: 0.5% solution, w/v. Dissolve 5 g potassium persulfate in 1 liter of distilled water.
- 6.8 Stock Mercury Solution: Dissolve 0.1354 g of mercuric chloride in 75 mL of distilled water. Add 10 mL of conc. nitric acid and adjust the volume to 100.0 mL. 1.0 mL = 1.0 mg Hg.
- 6.9 Working Mercury Solution: Make successive dilutions of the stock mercury solution (6.8) to obtain a working standard containing 0.1 ug per mL. This working standard and the dilutions of the stock mercury solution should be prepared fresh daily. Acidity of the working standard should be maintained at 0.15% nitric acid. This acid should be added to the flask as needed before the addition of the aliquot. From this solution prepare standards containing 0.2, 0.5, 1.0, 2.0, 5.0, 10.0, 15.0 and 20.0 ug Hg/L.
- 6.10 Air Scrubber Solution: Mix equal volumes of 0.1 N potassium permanganate (6.6) and 10% sulfuric acid (6.1.2).

7. Procedure (See Note 5)

- 7.1 Set up manifold as shown in Figure 2.
- 7.2 Feeding all the reagents through the system with acid wash solution (6.2.1) through the sample line, adjust heating bath to 105°C.
- 7.3 Turn on atomic absorption spectrophotometer, adjust instrument settings as recommended by the manufacturer, align absorption cell in light path for maximum transmittance and place heat lamp directly over absorption cell.
- 7.4 Arrange working mercury standards from 0.2 to 20.0 ug Hg/L in sampler and start sampling. Complete loading of sample tray with unknown samples.
- 7.5 Prepare standard curve by plotting peak height of processed standards against concentration values. Determine concentration of samples by comparing sample peak height with standard curve.
- 7.6 After the analysis is complete put all lines except the H<sub>2</sub>SO<sub>4</sub> line in distilled water to wash out system. After flushing, wash out the H<sub>2</sub>SO<sub>4</sub> line. Also flush the coils in the high temperature heating bath by pumping stannous sulfate (6.3) through the sample lines followed by distilled water. This will prevent build-up of oxides of manganese.

NOTE 5: Because of the toxic nature of mercury vapor, precaution must be taken to avoid its inhalation. Venting the mercury vapor into an exhaust hood or passing the vapor through some absorbing media such as: a) equal volumes of 0.1 N  $\text{KMnO}_4$  (6.6) and 10%  $\text{H}_2\text{SO}_4$  (6.1.2), or b) 0.25% iodine in a 3% KI solution, is recommended. A specially treated charcoal that will absorb mercury vapor is also available.

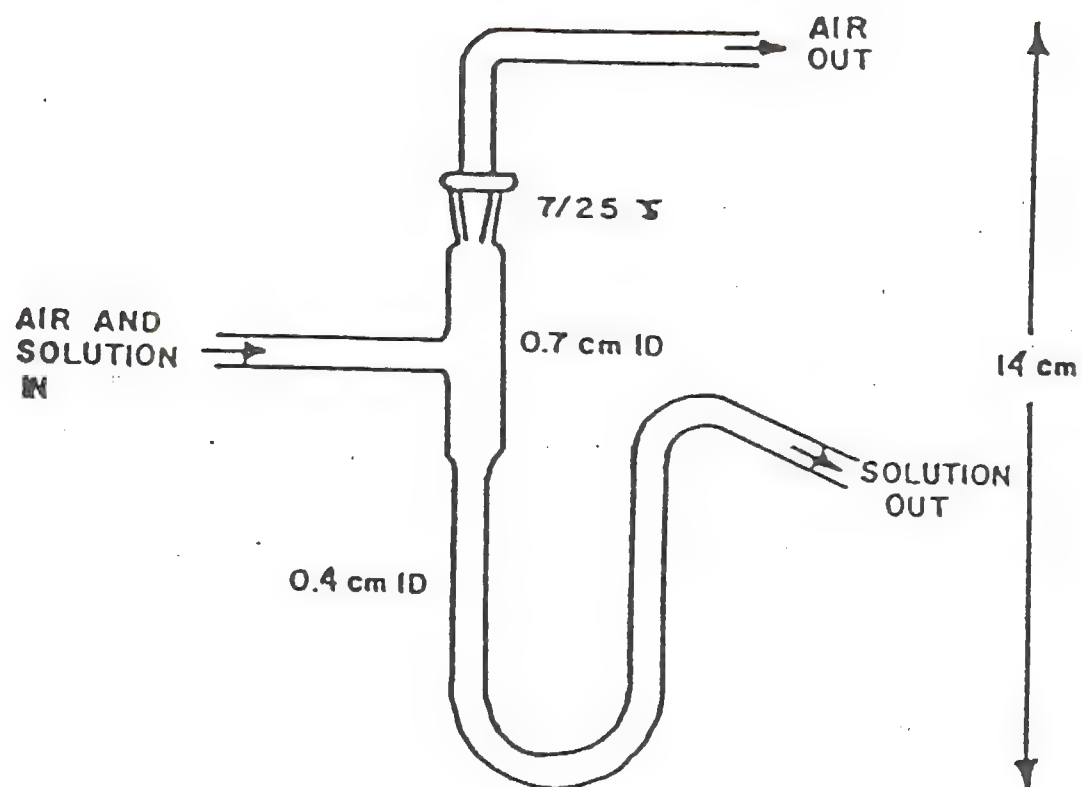


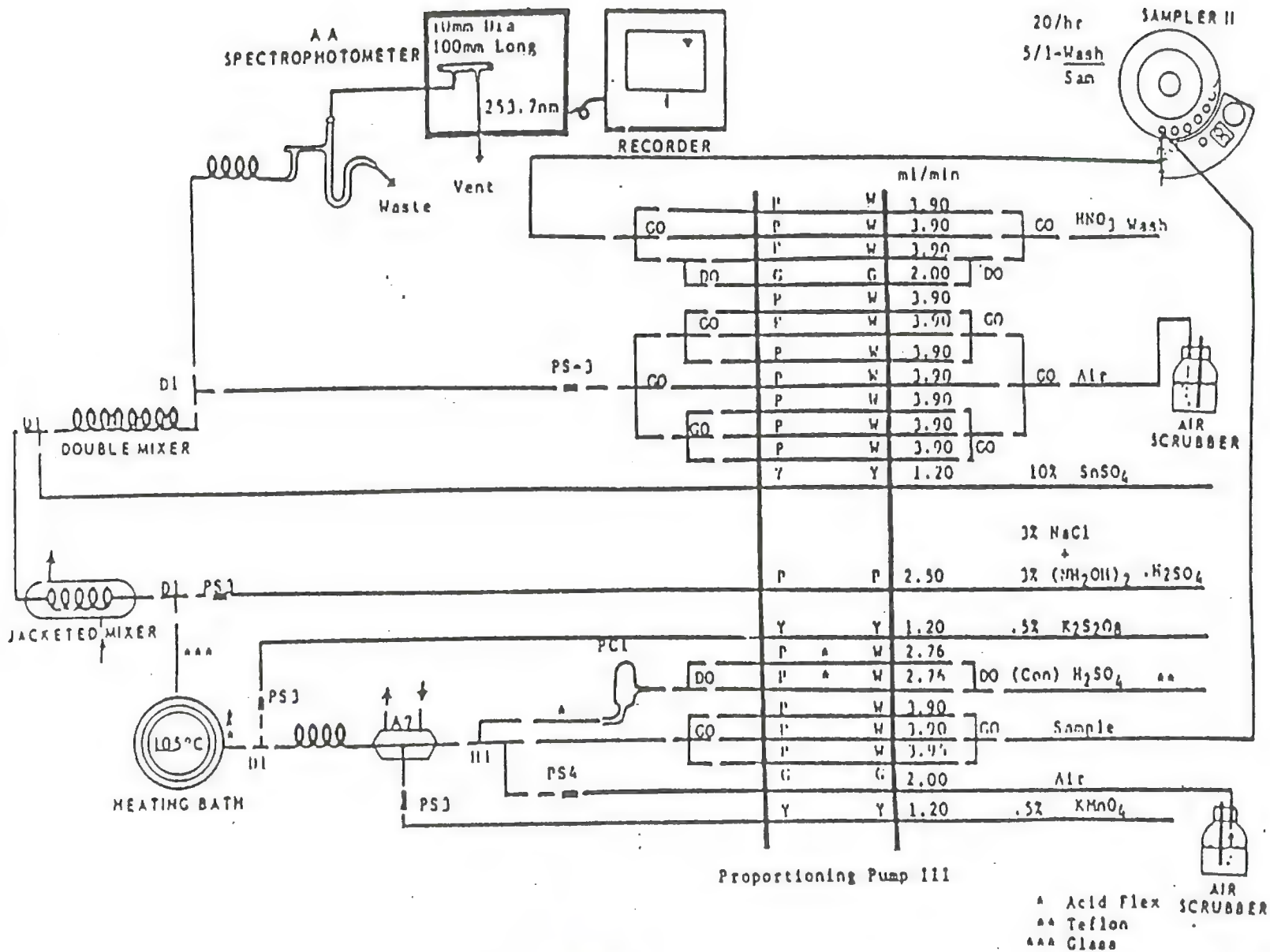
Figure 1. Vapor liquid separator  
D-56

ILM02.0



Figure 2. Mercury Manifold AA-1  
D-57

ILMO2.0



MERCURY ANALYSIS IN SOIL/SEDIMENT BY MANUAL COLD VAPOR TECHNIQUE

## MERCURY (in Sediments)

## Method 245.5 CLP-M\* (Manual Cold Vapor Technique)

1. Scope and Application

- 1.1 This procedure measures total mercury (organic and inorganic) in soils, sediments, bottom deposits and sludge type materials
- 1.2 The range of the method is 0.2 to 5 ug/g. The range may be extended above or below the normal range by increasing or decreasing sample size or through instrument and recorder control

2. Summary of Method

- 2.1 A weighed portion of the sample is acid digested for 2 minutes at 95°C, followed by oxidation with potassium permanganate and potassium persulfate. Mercury in the digested sample is then measured by the conventional cold vapor technique
- 2.2 An alternate digestion involving the use of an autoclave is described in (8.2)

3. Sample Handling and Preservation

- 3.1 Because of the extreme sensitivity of the analytical procedure and the omnipresence of mercury, care must be taken to avoid extraneous contamination. Sampling devices and sample containers should be ascertained to be free of mercury; the sample should not be exposed to any condition in the laboratory that may result in contact or air-borne mercury contamination
- 3.2 Refrigerate solid samples at 4°C ( $\pm 2^\circ$ ) upon receipt until analysis (see Exhibit D, Section II).
- 3.3 The sample should be analyzed without drying. A separate percent solids determination is required, (Part F).

4. Interferences

- 4.1 The same types of interferences that may occur in water samples are also possible with sediments, i.e., sulfides, high copper, high chlorides, etc.
- 4.2 Samples containing high concentrations of oxidizable organic materials, as evidenced by high chemical oxygen demand values, may not be completely oxidized by this procedure. When this occurs, the recovery of organic mercury will be low. The problem can be eliminated by reducing the weight of the original sample or by increasing the amount of potassium persulfate (and consequently stannous chloride) used in the digestion.

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\*CLP-M modified for the Contract Laboratory Program.

5. Apparatus

- 5.1 Atomic Absorption Spectrophotometer (see Note 1): Any atomic absorption unit having an open sample presentation area in which to mount the absorption cell is suitable. Instrument settings recommended by the particular manufacturer should be followed

NOTE 1: Instruments designed specifically for the measurement of mercury using the cold vapor technique are commercially available and may be substituted for the atomic absorption spectrophotometer

- 5.2 Mercury Hollow Cathode Lamp: Westinghouse WL-22847, argon filled, or equivalent
- 5.3 Recorder: Any multi-range variable speed recorder that is compatible with the UV detection system is suitable.
- 5.4 Absorption Cell: Standard spectrophotometer cells 10 cm long, having quartz end windows may be used. Suitable cells may be constructed from pexiglass tubing, 1" O.D. X 4-1/2". The ends are ground perpendicular to the longitudinal axis and quartz windows (1" diameter X 1/16" thickness) are cemented in place. Gas inlet and outlet ports (also of plexiglass but 1/4" O.D.) are attached approximately 1/2" from each end. The cell is strapped to a burner for support and aligned in the light beam to give the maximum transmittance. Two 2" X 2" cards with one inch diameter holes may be placed over each end of the cell to assist in positioning the cell for maximum transmittance.
- 5.5 Air Pump: Any peristaltic pump capable of delivering 1 liter of air per minute may be used. A Masterflex pump with electronic speed control has been found to be satisfactory. (Regulated compressed air can be used in an open one-pass system.)
- 5.6 Flowmeter: Capable of measuring an air flow of 1 liter per minute
- 5.7 Aeration Tubing: Tygon tubing is used for passage of the mercury vapor from the sample bottle to the absorption cell and return. Straight glass tubing terminating in a coarse porous frit is used for sparging air into the sample
- 5.8 Drying Tube: 6" X 3/4" diameter tube containing 20 g of magnesium perchlorate (see Note 2).

NOTE 2: In place of the magnesium perchlorate drying tube, a small reading lamp with 60W bulb may be used to prevent condensation of moisture inside the cell. The lamp is positioned to shine on the absorption cell maintaining the air temperature in the cell about 10°C above ambient.

6. Reagents

- 6.1 Sulfuric acid, conc.: Reagent grade of low mercury content
- 6.2 Nitric acid, conc.: Reagent grade of low mercury content

- 6.3 Stannous Sulfate: Add 25 g stannous sulfate to 250 mL of 0.5 N sulfuric acid (6.2). This mixture is a suspension and should be stirred continuously during use
- 6.4 Sodium Chloride-Hydroxylamine Sulfate (See Note 3) Solution: Dissolve 12 g of sodium chloride and 12 g of hydroxylamine sulfate in distilled water and dilute to 100 mL
- NOTE 3: A 10% solution of stannous chloride may be substituted for (6.3) and hydroxylamine hydrochloride may be used in place of hydroxylamine sulfate in (6.4)
- 6.5 Potassium Permanganate: 5% solution, w/v. Dissolve 5 g of potassium permanganate in 100 mL of distilled water
- 6.6 Potassium Persulfate: 5% solution, w/v. Dissolve 5 g of potassium persulfate in 100 mL of distilled water
- 6.7 Stock Mercury Solution: Dissolve 0.1354 g of mercuric chloride in 75 mL of distilled water. Add mL of conc. nitric acid and adjust the volume to 100.0 mL. 1.0 = 1.0 mg Hg
- 6.8 Working Mercury Solution: Make successive dilutions of the stock mercury solution (6.7) to obtain a working standard containing 0.1 ug/mL. This working standard and the dilution of the stock mercury solutions should be prepared fresh daily. Acidity of the working standard should be maintained at 0.15% nitric acid. This acid should be added to the flask as needed before the addition of the aliquot

#### Calibration

- 7.1 Transfer 0, 0.5, 1.0, 5.0 and 10 mL aliquots of the working mercury solutions (6.8) containing 0 to 1.0 ug of mercury to a series of 300 mL BOD bottles. Add enough distilled water to each bottle to make a total volume of 10 mL. Add 5 mL of conc.  $\text{H}_2\text{SO}_4$  (6.1) and 2.5 mL of conc.  $\text{HNO}_3$  (6.2) and heat 2 minutes in a water bath at 95°C. Allow the sample to cool and add 50 mL distilled water, 15 mL of  $\text{KMnO}_4$  solution (6.5) and 8 mL of potassium persulfate solution (6.6) to each bottle and return to the water bath for 30 minutes. Cool and add 6 mL of sodium chloride-hydroxylamine sulfate solution (6.4) to reduce the excess permanganate. Add 50 mL of distilled water. Treating each bottle individually, add 5 mL of stannous sulfate solution (6.3) and immediately attach the bottle to the aeration apparatus. At this point the sample is allowed to stand quietly without manual agitation. The circulating pump, which has previously been adjusted to a rate of 1 liter per minute, is allowed to run continuously. The absorbance, as exhibited either on the spectrophotometer or the recorder, will increase and reach maximum within 30 seconds. As soon as the recorder pen levels off, approximately 1 minute, open the bypass valve and continue the aeration until the absorbance returns to its minimum value (see Note 4). Close the bypass valve, remove the fritted tubing from the BOD bottle and continue the aeration. Proceed with the standards and construct a standard curve by plotting peak height versus micrograms of mercury



NOTE 4: Because of the toxic nature of mercury vapor, precaution must be taken to avoid its inhalation. Therefore, a bypass has been included in the system to either vent the mercury vapor into an exhaust hood or pass the vapor through some absorbing media, such as: a) equal volumes of 0.1 N  $\text{KMnO}_4$  and 10%  $\text{H}_2\text{SO}_4$ , or b) 0.25% iodine in a 3% KI solution. A specially treated charcoal that will absorb mercury vapor is also available.

## 8. Procedure

- 8.1 Weigh a representative 0.2 g portion of wet sample and place in the bottom of a BOD bottle. Add 5 mL of sulfuric acid (6.1) and 2.5 mL of concentrated nitric acid (6.2) mixing after each addition. Heat two minutes in a water bath at  $95^\circ\text{C}$ . Cool, add 50 mL distilled water, 15 mL potassium permanganate solution (6.5) and 8 mL of potassium persulfate solution (6.6) to each sample bottle. Mix thoroughly and place in the water bath for 30 minutes at  $95^\circ\text{C}$ . Cool and add 6 mL of sodium chloride-hydroxylamine sulfate (6.4) to reduce the excess permanganate. Add 55 mL of distilled water. Treating each bottle individually, purge the head space of the sample bottle for at least one minute and add 5 mL of stannous sulfate (6.3) and immediately attach the bottle to the aeration apparatus. Continue as described under (7.1)
- 8.2 An alternate digestion procedure employing an autoclave may also be used. In this method 5 mL of conc.  $\text{H}_2\text{SO}_4$  and 2 mL of conc.  $\text{HNO}_3$  are added to the 0.2 g of sample. 5 mL of saturated  $\text{KMnO}_4$  solution and 8 mL of potassium persulfate solution are added and the bottle is covered with a piece of aluminum foil. The sample is autoclaved at  $121^\circ\text{C}$  and 15 lbs. for 15 minutes. Cool, make up to a volume of 100 mL with distilled water and add 6 mL of sodium chloride-hydroxylamine sulfate solution (6.4) to reduce the excess permanganate. Purge the head space of the sample bottle for at least one minute and continue as described under (7.1)

## 9. Calculations

- 9.1 Measure the peak height of the unknown from the chart and read the mercury value from the standard curve
- 9.2 Calculate the mercury concentration in the sample by the formula:

$$\text{ug Hg/g} = \frac{\text{ug Hg in the aliquot}}{\text{wt of the aliquot in gms}} \quad (\text{based upon dry wt of the sample})$$

- 9.3 Report mercury concentrations as described for aqueous mercury samples converted to units of mg/kg. The sample result or the detection limit for each sample must be corrected for sample weight and % solids before reporting.

PART E - METHODS FOR CYANIDE ANALYSIS

Method

Page No.

Method for Total Cyanide Analysis in Water  
Method 335.2 CLP-M\*

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Method for Total Cyanide Analysis in Soil/Sediment  
Method 335.2 CLP-M

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Method for Total Cyanide Analysis by Midi Distillation  
Method 335.2 CLP-M

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\*CLP-M Modified for the Contract Laboratory Program.



METHOD FOR TOTAL CYANIDE ANALYSIS IN WATER

## CYANIDE, TOTAL (in Water)

Method 335.2 CLP-M\* (Titrimetric; Manual Spectrophotometric; Semi-Automated Spectrophotometric)

1. Scope and Application

- 1.1 This method is applicable to the determination of cyanide in drinking, surface and saline waters, domestic and industrial wastes.
- 1.2 The titration procedure using silver nitrate with p-dimethylaminobenzalrhodanine indicator is used for measuring concentrations of cyanide exceeding 1 mg/L (0.25 mg/250 mL of absorbing liquid). (Option A, 8.2).
- 1.3 The manual colorimetric procedure is used for concentrations below 1 mg/L of cyanide and is sensitive to about 0.01 mg/L. (Option B, 8.3).
- 1.4 The working range of the semi-automated spectrophotometric method is 0.020 to 0.200 mg/L. Higher level samples must be diluted to fall within the working range. (Option C, 8.4).

2. Summary of Method

- 2.1 The cyanide as (HRN) hydrocyanic acid (HCN) is released from cyanide complexes by means of a reflux-distillation operation and absorbed in a scrubber containing sodium hydroxide solution. The cyanide ion in the absorbing solution is then determined by volumetric titration or colorimetrically.
- 2.2 In the colorimetric measurement the cyanide is converted to cyanogen chloride,  $\text{CNCI}$ , by reaction with chloramine-T at a pH less than 8 without hydrolyzing to the cyanate. After the reaction is complete, color is formed on the addition of pyridine-pyrazolone or pyridinebarbituric acid reagent. The absorbance is read at 620 nm when using pyridine-pyrazolone or 578 nm for pyridine-barbituric acid. To obtain colors of comparable intensity, it is essential to have the same salt content in both the sample and the standards.
- 2.3 The titimetric measurement uses a standard solution of silver nitrate to titrate cyanide in the presence of a silver sensitive indicator.

3. Definitions

Cyanide is defined as cyanide ion and complex cyanides converted to hydrocyanic acid (HCN) by reaction in a reflux system of a mineral acid in the presence of magnesium ion.

4. Sample Handling and Preservation

- 4.1 All bottles must be thoroughly cleansed and rinsed to remove soluble material from containers.

CLP-M Modified for the Contract Laboratory Program.



- 4.2 Oxidizing agents such as chlorine decompose most of the cyanides. Test a drop of the sample with potassium iodide-starch test paper (KI-starch paper); a blue color indicates the need for treatment. Add ascorbic acid, a few crystals at a time, until a drop of sample produces no color on the indicator paper. Then add an additional 0.6 g of ascorbic acid for each liter of sample volume.
- 4.3 Samples are preserved with 2 mL of 10 N sodium hydroxide per liter of sample (pH > 12) at the time of collection (Exhibit D, Section II).
- 4.4 Samples must be stored at 4°C(±2°C) and must be analyzed within the holding time specified in Exhibit D, Section II.
5. Interferences
- 5.1 Interferences are eliminated or reduced by using the distillation procedure described in Procedure 8.1.
- 5.2 Sulfides adversely affect the colorimetric and titration procedures. If a drop of the distillate on lead acetate test paper indicates the presence of sulfides, treat 25 mL more of the sample than that required for the cyanide determination with powdered cadmium carbonate. Yellow cadmium sulfide precipitates if the sample contains sulfide. Repeat this operation until a drop of the treated sample solution does not darken the lead acetate test paper. Filter the solution through a dry filter paper into a dry beaker, and from the filtrate measure the sample to be used for analysis. Avoid a large excess of cadmium carbonate and a long contact time in order to minimize a loss by complexation or occlusion of cyanide on the precipitated material. Sulfides should be removed prior to preservation with sodium hydroxide as described in 4.3.
- 5.3 The presence of surfactants may cause the sample to foam during refluxing. If this occurs, the addition of an agent such as Dow Corning 544 antifoam agent will prevent the foam from collecting in the condenser. Fatty acids will distill and form soaps under alkaline titration conditions, making the end point almost impossible to detect. When this occurs, one of the spectrophotometric methods should be used.
6. Apparatus
- 6.1 Reflux distillation apparatus such as shown in Figure 1 or Figure 2. The boiling flask should be of 1 liter size with inlet tube and provision for condenser. The gas absorber may be a Fisher-Milligan scrubber.
- 6.2 Microburet, 5.0 mL (for titration)
- 6.3 Spectrophotometer suitable for measurements at 578 nm or 620 nm with a 1.0 cm cell or larger (for manual spectrophotometric method).
- 6.4 Technicon AA II System or equivalent instrumentation, (for automated spectrophotometric method) including:
- 6.4.1 Sampler
- 6.4.2 Pump III

- 6.4.3 Cyanide Manifold (Figure 3)
- 6.4.4 SCIC Colorimeter with 15 mm flowcells and 570 nm filters
- 6.4.5 Recorder
- 6.4.6 Data System (optional)
- 6.4.7 Glass or plastic tubes for the sampler

## 7. Reagents

### 7.1 Distillation and Preparation Reagents

- 7.1.1 Sodium hydroxide solution, 1.25N: Dissolve 50 g of NaOH in distilled water, and dilute to 1 liter with distilled water.
- 7.1.2 Cadmium carbonate: powdered
- 7.1.3 Ascorbic acid: crystals
- 7.1.4 Sulfuric acid: concentrated
- 7.1.5 Magnesium chloride solution: Weight 510 g of  $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$  into a 1000 mL flask, dissolved and dilute to 1 liter with distilled water.

### 7.2 Stock Standards and Titration Reagents

- 7.2.1 Stock cyanide solution: Dissolve 2.51 g of KCN and 2 g KOH in 1 liter of distilled water. Standardize with 0.0192 N  $\text{AgNO}_3$ .
- 7.2.2 Standard cyanide solution, intermediate: Dilute 50.0 mL of stock (1 mL = 1 mg CN) to 1000 mL with distilled water.
- 7.2.3 Standard cyanide solution: Prepare fresh daily by diluting 100.0 mL of intermediate cyanide solution to 1000 mL with distilled water and store in a glass stoppered bottle. 1 mL = 5.0 ug CN (5.0 mg/L).
- 7.2.4 Standard silver nitrate solution, 0.0192 N: Prepare by crushing approximately 5 g  $\text{AgNO}_3$  crystals and drying to constant weight at  $40^\circ\text{C}$ . Weight out 3.2647 g of dried  $\text{AgNO}_3$ , dissolve in distilled water, and dilute to 1000 mL (1 mL = 1 mg CN).
- 7.2.5 Rhodanine indicator: Dissolve 20 mg of p-dimethyl-aminobenzalrhodanine in 100 mL of acetone.
- 7.2.6 Sodium hydroxide solution, 0.25 N: Dissolve 10 g or NaOH in distilled water and dilute to 1 liter.

### 7.3 Manual Spectrophotometric Reagents

- 7.3.1 Sodium dihydrogenphosphate, 1 M: Dissolve 138 g of  $\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$  in a liter of distilled water. Refrigerate this solution.

7.3.2 Chloramine-T solution: Dissolve 1.0 g of white, water soluble chloramine-T in 100 mL of distilled water and refrigerate until ready to use. Prepare fresh weekly.

7.3.3 Color Reagent-One of the following may be used:

7.3.3.1 Pyridine-barbituric acid reagent: Place 15 g of barbituric acid in a 250 mL volumetric flask and add just enough distilled water to wash the sides of the flask and wet the barbituric acid. Add 75 mL of pyridine and mix. Add 15 mL of HCl (sp gr 1.19), mix, and cool to room temperature. Dilute to 250 mL with distilled water and mix. This reagent is stable for approximately six months if stored in a cool, dark place.

7.3.3.2 Pyridine-pyrazolone solution: 7.3.3.2.1 3-Methyl-1-phenyl-2-pyrazolin-5-one reagent, saturated solution: Add 0.25 g of 3-methyl-1-phenyl-2-pyrazolin-5-one to 50 mL of distilled water, heat to 60°C with stirring. Cool to room temperature.

7.3.3.2.1 3-Methyl-1-phenyl-2-pyrazolin-5-one reagent, saturated solution: Add 0.25 g of 3-methyl-1-phenyl-2-pyrazolin-5-one to 50 mL of distilled water, heat to 60°C with stirring. Cool to room temperature.

7.3.3.2.2 3,3'-Dimethyl-1,1'-diphenyl [4,4'-bi-2 pyrazolin]-5,5'-dione (bispyrazolone): Dissolve 0.01 g of bispyrazolone in 10 mL of pyridine.

7.3.3.2.3 Pour solution (7.3.3.2.1) through nonacid-washed filter paper. Collect the filtrate. Through the same filter paper pour solution (7.3.3.2.2) collecting the filtrate in the same container as filtrate from (7.3.3.2.1). Mix until the filtrates are homogeneous. The mixed reagent develops a pink color but this does not affect the color production with cyanide if used within 24 hours of preparation.

#### 7.4 Semi-Automated Spectrophotometric Reagents

7.4.1 Chloramine-T solution: Dissolve 0.40 g of chloramine-T in distilled water and dilute to 100 mL. Prepare fresh daily.

7.4.2 Phosphate buffer: Dissolve 138 g of  $\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$  in distilled water and dilute to 1 liter. Add 0.5 mL of Brij-35 (available from Technicon). Store at 4°C ( $\pm 2^\circ\text{C}$ ).

7.4.3 Pyridine-barbituric acid solution: Transfer 15 g of barbituric acid into a 1 liter volumetric flask. Add about 100 mL of distilled water and swirl the flask. Add 74 mL of pyridine and mix. Add 15 mL of

concentrated HCl and mix. Dilute to about 900 mL with distilled water and mix until the barbituric acid is dissolved. Dilute to 1 liter with distilled water. Store at  $4^{\circ}\text{C}(\pm 2^{\circ}\text{C})$ .

- 7.4.4 Sampler wash: Dissolve 10 g of NaOH in distilled water and dilute to 1 liter.

## 8. Procedure

### 8.1 Distillation

- 8.1.1 Place 500 mL of sample in the 1 liter boiling flask. Add 50 mL, of sodium hydroxide (7.1.1) to the absorbing tube and dilute if necessary with distilled water to obtain an adequate depth of liquid in the absorber. Connect the boiling flask, condenser, absorber and trap in the train.

- 8.1.2 Start a slow stream of air entering the boiling flask by adjusting the vacuum source. Adjust the vacuum so that approximately one bubble of air per second enters the boiling flask through the air inlet tube.

NOTE: The bubble rate will not remain constant after the reagents have been added and while heat is being applied to the flask. It will be necessary to readjust the air rate occasionally to prevent the solution in the boiling flask from backing up into the air inlet tube.

- 8.1.3 Slowly add 25 mL concentrated sulfuric acid (7.1.4) through the air inlet tube. Rinse the tube with distilled water and allow the airflow to mix the flask contents for 3 minutes. Pour 20 mL of magnesium chloride solution (7.1.5) into the air inlet and wash down with a stream of water.
- 8.1.4 Heat the solution to boiling, taking care to prevent the solution from backing up into and overflowing from the air inlet tube. Reflux for one hour. Turn off heat and continue the airflow for at least 15 minutes. After cooling the boiling flask, disconnect absorber and close off the vacuum source.
- 8.1.5 Drain the solution from the absorber into a 250 mL volumetric flask and bring up to volume with distilled water washings from the absorber tube.

### 8.2 Titrimetric Determination (Option A)

- 8.2.1 If the sample contains more than 1 mg of CN, transfer the distillate, or a suitable aliquot diluted to 250 mL, to a 500 mL Erlenmeyer flask. Add 10-12 drops of the benzalrhodanine indicator.
- 8.2.2 Titrate with standard silver nitrate to the first change in color from yellow to brownish-pink. Titrate a distilled water blank using the same amount of sodium hydroxide and indicator as in the sample.



- 8.2.3 The analyst should familiarize himself with the end point of the titration and the amount of indicator to be used before actually titrating the samples. A 5 or 10 mL microburet may be conveniently used to obtain a more precise titration.

### 8.3 Manual Spectrophotometric Determination (Option B)

- 8.3.1 Withdraw 50 mL or less of the solution from the flask and transfer to a 100 mL volumetric flask. If less than 50 mL is taken, dilute to 50 mL with 0.25 N sodium hydroxide solution (7.2.6). Add 15.0 mL of sodium phosphate solution (7.3.1) and mix. The dilution factor must be reported on Form XIV.

8.3.1.1 Pyridine-barbituric acid method: Add 2 mL of chloramine-T (7.3.2) and mix. After 1 to 2 minutes, add 5 mL of pyridine-barbituric acid solution (7.3.3.1) and mix. Dilute to mark with distilled water and mix again. Allow 8 minutes for color development then read absorbance at 578 nm in a 1 cm cell within 15 minutes.

8.3.1.2 Pyridine-pyrazolone method: Add 0.5 mL of chloramine-T (7.3.2) and mix. After 1 to 2 minutes, add 5 mL of pyridine-pyrazolone solution (7.3.3.2) and mix. Dilute to mark with distilled water and mix again. After 40 minutes, read absorbance at 620 nm in a 1 cm cell. NOTE: More than 0.5 mL of chloramine-T will prevent the color from developing with pyridine-pyrazolone.

- 8.3.2 Prepare a minimum of 3 standards and a blank by pipetting suitable volumes of standard solution into 250 mL volumetric flasks. NOTE: One calibration standard must be at the Contract Required Detection Limit (CRDL). To each standard, add 50 mL of 1.25 N sodium hydroxide and dilute to 250 mL with distilled water. Standards must bracket the concentration of the samples. If dilution is required, use the blank solution.

As an example, standard solutions could be prepared as follows:

| <u>mL of Standard Solution</u><br><u>(1.0 - 5 ug CN)</u> | <u>Conc. ug CN</u><br><u>per 250 mL</u> |
|--|---|
| 0  | Blank                                   |
| 1.0  | 5                                       |
| 2.0  | 10                                      |
| 5.0  | 25                                      |
| 10.0   | 50                                      |
| 15.0   | 75                                      |
| 20.0   | 100                                     |

- 8.3.2.1 It is not imperative that all standards be distilled in the same manner as the samples. At least one standard (mid-range) must be distilled and compared to similar values on the curve to ensure that the distillation technique is reliable. If the distilled standard does not

agree within  $\pm 15\%$  of the undistilled standards, the operator should find and correct the cause of the apparent error before proceeding.

- 8.3.2.2 Prepare a standard curve by plotting absorbance of standard vs. cyanide concentrations (per 250 mL).

#### 8.4 Semi-Automated Spectrophotometric Determination (Option C)

- 8.4.1 Set up the manifold as shown in Figure 3. Pump the reagents through the system until a steady baseline is obtained.
- 8.4.2 Calibration standards: Prepare a blank and at least three calibration standards over the range of the analysis. One calibration standard must be at the CRDL. For a working range of 0-200 ug/L, the following standards may be used:

| <u>mL Standard Solution</u><br><u>(7.2.3) diluted to 1 liter</u> | <u>Concentration</u><br><u>ug CN/L</u> |
|--|--|
| 0  | 0                                      |
| 4.0  | 20                                     |
| 10.0   | 50                                     |
| 20.0   | 100                                    |
| 30.0   | 150                                    |
| 40.0   | 200                                    |

Add 10 g of NaOH to each standard. Store at  $4^{\circ}\text{C}(\pm 2^{\circ}\text{C})$

- 8.4.3 Place calibration standards, blanks, and control standards in the sampler tray, followed by distilled samples, distilled duplicates, distilled standards, distilled spikes, and distilled blanks.
- 8.4.4 When a steady reagent baseline is obtained and before starting the sampler, adjust the baseline using the appropriate knob on the colorimeter. Aspirate a calibration standard and adjust the STD CAL dial on the colorimeter until the desired signal is obtained. Record the STD CAL value. Re-establish the baseline and proceed to analyze calibration standards, blanks, control standards, distilled samples, and distilled QC audits.

#### 9. Calculations

- 9.1 Using the titrimetric procedure, calculate concentration of CN as follows:

$$\text{CN, mg/L} = \frac{(A-B) \text{ 1.000 mL/L}}{\text{mL orig. sample}} \times \frac{250 \text{ mL}}{\text{mL of aliquot titrated}}$$

WHERE: A - volume of  $\text{AgNO}_3$  for titration of sample  
(1 mL = 1 mg Ag)

B - volume of  $\text{AgNO}_3$  for titration of blank  
(1 mL = 1 mg Ag)

AND: 250 mL - distillate volume (See 8.1.5)  
1000 mL - conversion mL to L  
mL original sample (See 8.1.1)  
mL of aliquot titrated (See 8.2.1)

- 9.2 If the semi-automated method is used, measure the peak heights of the calibration standards (visually or using a data system) and calculate a linear regression equation. Apply the equation to the samples and QC audits to determine the cyanide concentration in the distillates. To determine the concentration of cyanide in the original sample, MULTIPLY THE RESULTS BY ONE-HALF (since the original volume was 500 mL and the distillate volume was 250 mL). Also, correct for, and report on Form XIV, any dilutions which were made before or after distillation.

The minimum concentration that can be reported from the calibration curve is 20 ug/L that corresponds to 10 ug/L in a sample that has been distilled.

- 9.3 If the colorimetric procedure is used, calculate the cyanide, in ug/L, in the original sample as follows:

$$\text{CN, ug/L} = \frac{A \times 1.000 \text{ mL/L}}{B} \times \frac{50 \text{ mL}}{C}$$

WHERE: A - ug CN read from standard curve (per 250 mL)  
B - mL of original sample for distillation (See 8.1.1)  
C - mL taken for colorimetric analysis (See 8.3.1)

AND: 50 mL - volume of original sample aliquot (See 8.3.1)  
1000 mL/L - conversion mL to L

The minimum value that can be substituted for A is 5 ug per 250 mL. That yields a concentration of 10 ug/L in the distilled sample.

## METHOD FOR TOTAL CYANIDE ANALYSIS IN SOIL/SEDIMENT

## CYANIDE, TOTAL (in Sediments)

Method 335.2 CLP-M\* (Titrimetric; Manual Spectrophotometric;  
Semi-Automated Spectrophotometric)

Scope and Application

This method is applicable to the determination of cyanide in sediments and other solids.

The detection limit is dependent upon the weight of sample taken for analysis.

Summary of Method

The cyanide as hydrocyanic acid (HCN) is released from cyanide complexes by means of a reflux-distillation operation and absorbed in a scrubber containing sodium hydroxide solution. The cyanide ion in the absorbing solution is then determined by volumetric titration or colorimetrically.

In the colorimetric measurement the cyanide is converted to cyanogen chloride,  $CNCl$ , by reaction with chloramine-T at a pH less than 8 without hydrolyzing to the cyanate. After the reaction is complete, color is formed on the addition of pyridine-pyrazolone or pyridine-barbituric acid reagent. The absorbance is read at 620 nm when using pyridine-pyrazolone for 578 nm for pyridine-barbituric acid. To obtain colors of comparable intensity, it is essential to have the same salt content in both the sample and the standards.

The titrimetric measurement uses a standard solution of silver nitrate to titrate cyanide in the presence of a silver sensitive indicator.

Definitions

Cyanide is defined as cyanide ion and complex cyanides converted to hydrocyanic acid (HCN) by reaction in a reflux system of a mineral acid in the presence of magnesium ion.

Sample Handling and Preservation

Samples must be stored at  $4^{\circ}C(\pm 2^{\circ}C)$  and must be analyzed within the holding time specified in Exhibit D, Section II.

Samples are not dried prior to analysis. A separate percent solids determination must be made in accordance with the procedure in Part F.

Interferences

Interferences are eliminated or reduced by using the distillation procedure described in Procedure 8.1.

Sulfides adversely affect the colorimetric and titration procedures.

Modified for the Contract Laboratory Program.



- 5.3 The presence of surfactants may cause the sample to foam during refluxing. If this occurs, the addition of an agent such as DOW Corning 544 antifoam agent will prevent the foam from collecting in the condenser. Fatty acids will distill and form soaps under the alkaline titration conditions, making the end point almost impossible to detect. When this occurs, one of the spectrophotometric methods should be used.

6. Apparatus

- 6.1 Reflux distillation apparatus such as shown in Figure 1 or Figure 2. The boiling flask should be of 1 liter size with inlet tube and provision for condenser. The gas absorber may be a Fisher-Milligan scrubber.
- 6.2 Microburet, 5.0 mL (for titration)
- 6.3 Spectrophotometer suitable for measurements at 578 nm or 620 nm with a 1.0 cm cell or larger.
- 6.4 Technicon AA II System or equivalent instrumentation (for automated spectrophotometric method) including:
- 6.4.1 Sampler
  - 6.4.2 Pump III
  - 6.4.3 Cyanide Manifold (Figure 3)
  - 6.4.4 SCIC Colorimeter with 15 mm flowcells and 570 nm filters
  - 6.4.5 Recorder
  - 6.4.6 Data System (optional)
  - 6.4.7 Glass or plastic tubes for the sampler

7. Reagents

7.1 Distillation and Preparation Reagents

- 7.1.1 Sodium hydroxide solution, 1.25N: Dissolve 50 g of NaOH in distilled water, and dilute to 1 liter with distilled water.
- 7.1.2 Cadmium carbonate: powdered
- 7.1.3 Ascorbic acid: crystals
- 7.1.4 Sulfuric acid: concentrated
- 7.1.5 Magnesium chloride solution: Weigh 510 g of  $MgCl_2 \cdot 6H_2O$  into a 1000 mL flask, dissolve and dilute to 1 liter with distilled water.

7.2 Stock Standards and Titration Reagents

- 7.2.1 Stock cyanide solution: Dissolve 2.51 g of KCN and 2 g KOH in 1 liter of distilled water. Standardize with 0.0192 N  $AgNO_3$ .

- 7.2.2 Standard cyanide solution, intermediate: Dilute 50.0 mL of stock (1 mL = 1 mg CN) to 1000 mL with distilled water (1 mL = 50.0 ug).
- 7.2.3 Standard cyanide solution: Prepare fresh daily by diluting 100.0 mL of intermediate cyanide solution to 1000 mL with distilled water and store in a glass stoppered bottle: 1 mL = 5.0 ug CN (5.0 mg/L).
- 7.2.4 Standard silver nitrate solution, 0.0192 N: Prepare by crushing approximately 5 g AgNO<sub>3</sub> crystals and drying to constant weight at 40°C. Weigh out 3.2647 g of dried AgNO<sub>3</sub>, dissolve in distilled water, and dilute to 1000 mL (1 mL = 1 mg CN).
- 7.2.5 Rhodanine indicator: Dissolve 20 mg of p-dimethyl-amino-benzalrhodanine in 100 mL acetone.

### 7.3 Manual Spectrophotometric Reagents

- 7.3.1 Sodium dihydrogenphosphate, 1 M: Dissolve 138 g of NaH<sub>2</sub>PO<sub>4</sub>·H<sub>2</sub>O in 1 liter of distilled water. Refrigerate this solution.
- 7.3.2 Chloramine-T solution: Dissolve 1.0 g of white, water soluble Chloramine-T in 100 mL of distilled water and refrigerate until ready to use. Prepare fresh weekly.
- 7.3.3 Color reagent - One of the following may be used:
- 7.3.3.1 Pyridine-barbituric acid reagent: Place 15 g of barbituric acid in a 250 mL volumetric flask and add just enough distilled water to wash the sides of the flask and wet the barbituric acid. Add 75 mL of pyridine and mix. Add 15 mL of HCl (sp gr 1.19), mix, and cool to room temperature. Dilute to 250 mL with distilled water and mix. This reagent is stable for approximately six months if stored in a cool, dark place.
- 7.3.3.2 Pyridine-pyrazolone solution:
- 7.3.3.2.1 3-Methyl-1-phenyl-2-pyrazolin-5-one reagent, saturated solution: Add 0.25 g of 3-methyl-1-phenyl-2-pyrazolin-5-one to 50 mL of distilled water, heat to 60°C with stirring. Cool to room temperature.
- 7.3.3.2.2 3,3'-Dimethyl-1,1'-diphenyl-[4,4'-bi-2-pyrazolin]-5,5'-dione (bispyrazolone): Dissolve 0.01 g of bispyrazolone in 10 mL of pyridine.
- 7.3.3.2.3 Pour solution (7.3.3.2.1) through non-acid-washed filter paper. Collect the filtrate. Through the same filter paper pour solution (7.3.3.2.2) collecting the filtrate in the same container as filtrate from (7.3.3.2.1). Mix until the filtrates are homogeneous. The mixed reagent develops a pink color but this

does not affect the color production with cyanide if used within 24 hours of preparation.

#### 7.4 Semi-Automated Spectrophotometric Reagents

- 7.4.1 Chloramine-T solution: Dissolve 0.40 g of chloramine-T in distilled water and dilute to 100 mL. Prepare fresh daily.
- 7.4.2 Phosphate Buffer: Dissolve 138 g of  $\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$  in distilled water and dilute to 1 liter. Add 0.5 mL of Brij-35 (available from Technicon). Store at 4°C.
- 7.4.3 Pyridine-barbituric acid solution: Transfer 15 g of barbituric acid into a 1 liter volumetric flask. Add about 100 mL of distilled water and swirl the flask. Add 74 mL of pyridine and mix. Add 15 mL of conc. HCl mix until the barbituric acid is dissolved. Dilute to 1 liter with distilled water. Store at 4°C.
- 7.4.4 Sampler Wash: Dissolve 10 g of NaOH in distilled water and dilute to 1 liter.

#### 8. Procedure

##### 8.1 Distillation

- 8.1.1 Accurately weigh a representative 1-5 g portion of wet sample and transfer it to a boiling flask. Add 500 mL of distilled water. Shake or stir the sample so that it is dispersed.
- 8.1.2 Add 50 mL of sodium hydroxide (7.1.1) to the absorbing tube and dilute if necessary with distilled water to obtain an adequate depth of liquid in the absorber. Connect the boiling flask, condenser, absorber, and trap in the train.
- 8.1.3 Start a slow stream of air entering the boiling flask by adjusting the vacuum source. Adjust the vacuum so that approximately one bubble of air per second enters the boiling flask through the air inlet tube.

NOTE: The bubble rate will not remain constant after the reagents have been added and while heat is being applied to the flask. It will be necessary to readjust the air rate occasionally to prevent the solution in the boiling flask from backing up into the air inlet tube.

- 8.1.4 Slowly add 25 mL of conc. sulfuric acid (7.1.4) through the air inlet tube. Rinse the tube with distilled water and allow the airflow to mix the flask contents for 3 minutes. Pour 20 mL of magnesium chloride solution (7.1.5) into the air inlet and wash down with a stream of water.

- 8.1.5 Heat the solution to boiling, taking care to prevent the solution from backing up and overflowing into the air inlet tube. Reflux for one hour. Turn off heat and continue the airflow for at least 15 minutes. After cooling the boiling flask, disconnect absorber and close off the vacuum source.
- 8.1.6 Drain the solution from the absorber into a 250 mL volumetric flask and bring up to volume with distilled water washings from the absorber tube.

## 8.2 Titrimetric Determination (Option A)

- 8.2.1 If the sample contains more than 1 mg of CN, transfer the distillate, or a suitable aliquot diluted to 250 mL, to a 500 mL Erlenmeyer flask. Add 10-12 drops of the benzalrhodanine indicator.
- 8.2.2 Titrate with standard silver nitrate to the first change in color from yellow to brownish-pink. Titrate a distilled water blank using the same amount of sodium hydroxide and indicator as in the sample.
- 8.2.3 The analyst should familiarize himself with the end point of the titration and the amount of indicator to be used before actually titrating the samples. A 5 or 10 mL microburet may be conveniently used to obtain a more precise titration.

## 8.3 Manual Spectrophotometric Determination (Option B)

- 8.3.1 Withdraw 50 mL or less of the solution from the flask and transfer to a 100 mL volumetric flask. If less than 50 mL is taken, dilute to 50 mL with 0.25 N sodium hydroxide solution (7.2.6). Add 15.0 mL of sodium phosphate solution (7.3.2) and mix.

8.3.1.1 Pyridine-barbituric acid method: Add 2 mL of Chloramine-T (7.3.2) and mix. After 1 to 2 minutes, add 5 mL of pyridine-barbituric acid solution (7.3.3.1) and mix. Dilute to mark with distilled water and mix again. Allow 8 minutes for color development then read absorbance at 578 nm in a 1 cm cell within 15 minutes.

8.3.1.2 Pyridine-pyrazolone method: Add 0.5 mL of chloramine-T (7.3.2) and mix. After 1 to 2 minutes add 5 mL of pyridine-pyrazolone solution (7.3.3.2) and mix. Dilute to mark with distilled water and mix again. After 40 minutes read absorbance at 620 nm in a 1 cm cell.

NOTE: More than 0.5 mL of chloramine-T will prevent the color from developing with pyridine-pyrazolone.

- 8.3.2 Prepare a minimum of three standards and a blank by pipetting suitable volumes of standard solution into 250 mL volumetric flasks.

NOTE: One calibration standard, must be made at the CRDL. To each standard add 50 mL of 1.25 N sodium hydroxide and dilute to 250 mL with distilled water. Standards must bracket the concentrations of the sample. If dilution is required, use the blank solution.



As an example, standard solutions could be prepared as follows:

| <u>mL of Standard Solution</u><br><u>(1.0 = 5 ug CN)</u> | <u>Conc. ug CN</u><br><u>per 250 mL</u> |
|--|---|
| 0  | Blank                                   |
| 1.0  | 5                                       |
| 2.0  | 10                                      |
| 5.0  | 25                                      |
| 10.0   | 50                                      |
| 15.0   | 75                                      |
| 20.0   | 100                                     |

8.3.2.1 It is not imperative that all standards be distilled in the same manner as the samples. At least one standard (mid-range) must be distilled and compared to similar values on the curve to insure that the distillation technique is reliable. If the distilled standard does not agree within +15% of the undistilled standards the operator should find and correct the cause of the apparent error before proceeding.

8.3.2.2 Prepare a standard curve by plotting absorbance of standard vs. cyanide concentrations (per 250 mL)

#### 8.4 Semi-Automated Spectrophotometric Determination (Option C)

8.4.1 Set up the manifold as shown in Figure 3. Pump the reagents through the system until a steady baseline is obtained.

8.4.2 Calibration standards: Prepare a blank and at least three calibration standards over the range of the analysis. One calibration standard must be at the CRDL. For a working range of 0-200 ug/L, the following standards may be used:

| <u>mL Standard Solution</u><br><u>(7.2.3) diluted to 1 liter</u> | <u>Concentration</u><br><u>ug CN/L</u> |
|--|--|
| 0  | 0                                      |
| 4.0  | 20                                     |
| 10.0   | 50                                     |
| 20.0   | 100                                    |
| 30.0   | 150                                    |
| 40.0   | 200                                    |

Add 10 g of NaOH to each standard. Store at 4°C(±2°C).

8.4.3 Place calibration standards, blanks, and control standards in the sampler tray, followed by distilled samples, distilled duplicates, distilled standards, distilled spikes, and distilled blanks.

8.4.4 When a steady reagent baseline is obtained and before starting the sampler, adjust the baseline using the appropriate knob on the colorimeter. Aspirate a calibration standard and adjust the STD CAL dial on the colorimeter until the desired signal is obtained. Record.

the STD CAL value. Reestablish the baseline and proceed to analyze calibration standards, blanks, control standards, distilled samples, and distilled QC audits.

## 9. Calculations

9.1 A separate determination of percent solids must be performed (see Part F).

9.2 The concentration of cyanide in the sample is determined as follows.

### 9.2.1 (Titration)

$$\text{CN, mg/kg} = \frac{(A - B) \times \frac{250 \text{ mL}}{\text{mL aliquot titrated}} \times 1000 \text{ g/kg}}{C \times \frac{\% \text{solids}}{100}}$$

WHERE: A - mL of AgNO<sub>3</sub> for titration of sample  
(1 mL = 1 mg Ag)  
B - mL of AgNO<sub>3</sub> for titration of blank  
(1 mL = 1 mg Ag)  
C - wet weight of original sample in g  
(See 8.1.1)

AND: 250 mL - volume of distillate (See 8.1.6)  
1000 g/kg - conversion factor g to kg  
mL aliquot titrated (See 8.2.1)  
% solids (see Part F)

### 9.2.2 (Manual Spectrophotometric)

$$\text{CN, mg/kg} = \frac{A \times \frac{50 \text{ mL}}{B}}{C \times \frac{\% \text{solids}}{100}}$$

WHERE: A - ug CN read from standard curve (per 250 mL)  
B - mL of distillate taken for colorimetric determination (8.3.1)  
C - wet weight of original sample in g  
(See 8.1.1)

The minimum value that can be substituted for A is 5 ug/250 mL. That yields a concentration of 10 ug/L in the distilled sample.

AND: 50 mL - volume of standard taken for colorimetric determination (See 8.3.1)  
% solids (see Part F)

## 9.2.3 (Semi-Automated Spectrophotometric)

If the semi-automated method is used, measure the peak heights of the calibration standards (visually or using a data system) and calculate a linear regression equation. Apply the equation to the samples and QC audits to determine the cyanide concentration in the distillates.

$$\text{CN, mg/kg} = \frac{A \times .25}{C \times \frac{\% \text{ solids}}{100}}$$

WHERE: A - ug/L determined from standard curve  
C - wet weight of original sample in g  
(See 8.1.1)

AND: .25 - conversion factor for distillate final  
volume (See 8.1.6)  
% solids (see Part F)

The minimum value that can be substituted for A is 5 ug/250 mL.

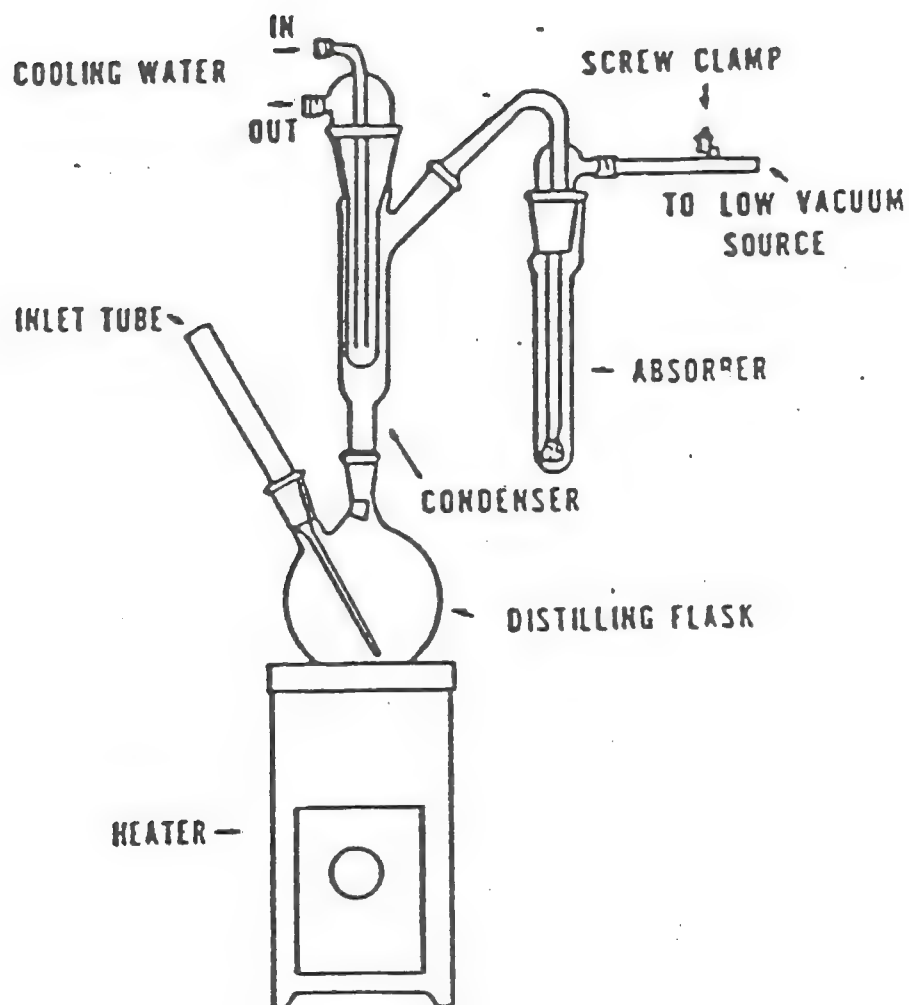


Figure 1. Cyanide distillation apparatus  
D-79



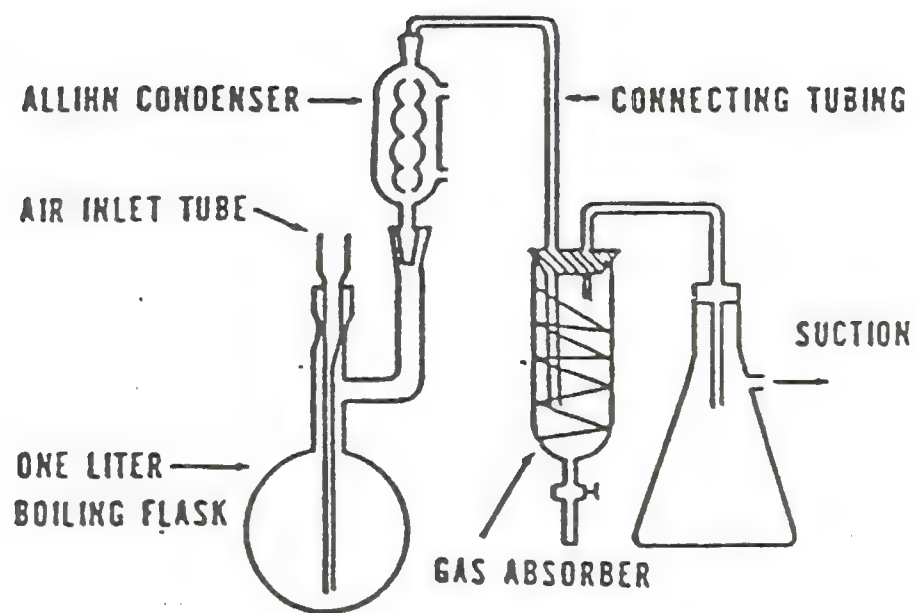


Figure 2. Cyanide distillation apparatus  
D-80

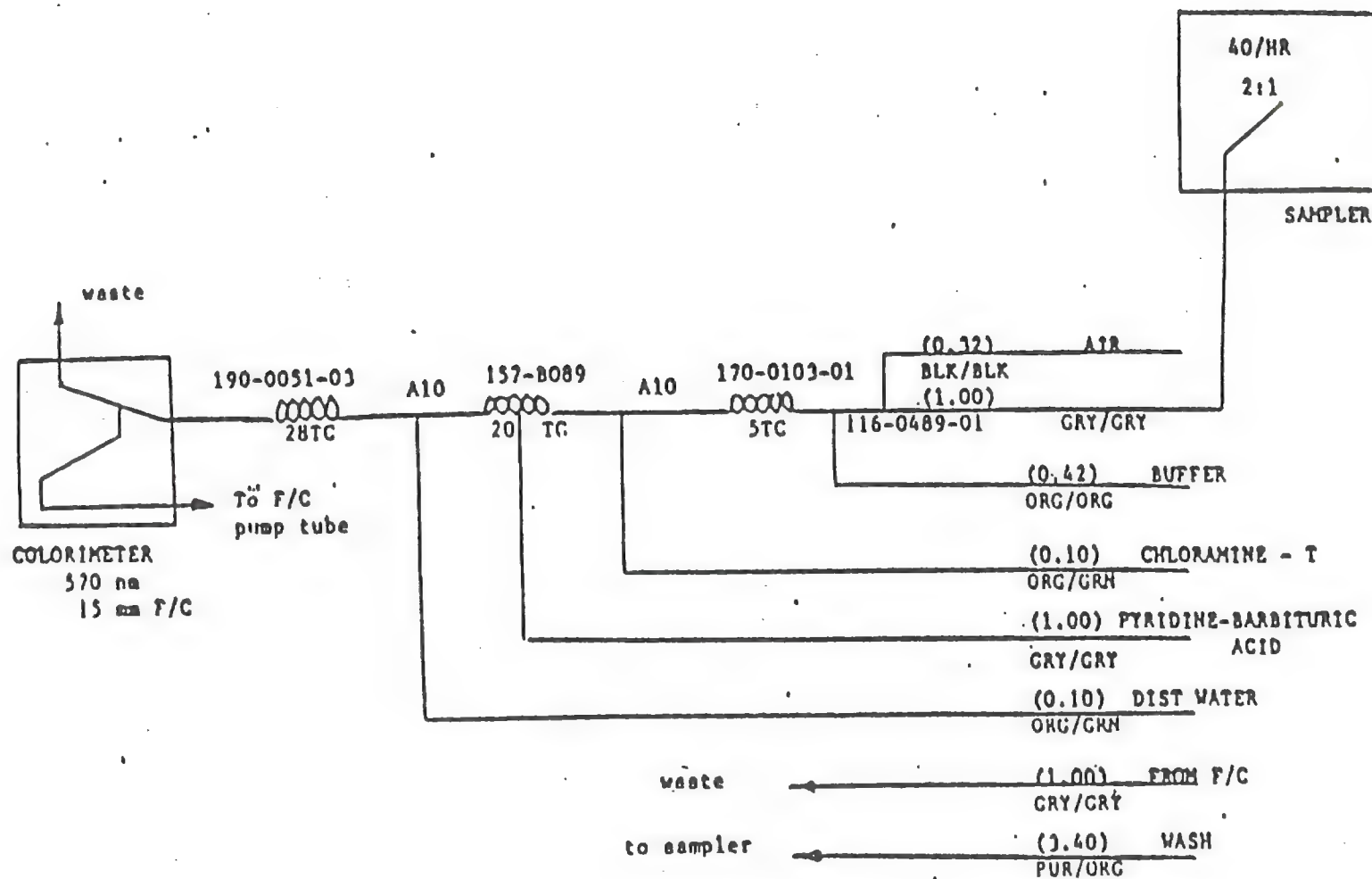


Figure 3. Cyanide Manifold  
D-81

ILM02.0

METHOD FOR TOTAL CYANIDE ANALYSIS BY MIDI DISTILLATION

## CYANIDE, TOTAL (water and soils)

## Method 335.2 CLP-M (Semi-automated Spectrophotometric)

1. Scope and Application

- 1.1 Cyanide determined by this method is defined as cyanide ion and complex cyanides converted to hydrocyanic acid by reaction in a reflux system with mineral acid in the presence of magnesium ion.
- 1.2 This method covers the determination of cyanide by midi distillation with a semi-automated colorimetric analysis of the distillate.
- 1.3 The detection limit for the semi-automated colorimetric method is approximately 10 ug/L.

2. Summary of Method

- 2.1 The cyanide as hydrocyanic acid (HCN) is released from cyanide complexes by means of a midi reflux-distillation operation and absorbed in a scrubber containing sodium hydroxide solution. The cyanide ion in the absorbing solution is then determined colorimetrically.
- 2.2 In the colorimetric measurement, the cyanide is converted to cyanogen chloride, CNCl, by reaction with chloramine-T at pH less than 8 without hydrolysis to the cyanate. After the reaction is complete, color is formed on the addition of pyridinebarbituric acid reagent. The absorbance is read at 580 nm. To obtain colors of comparable intensity, it is essential to have the same salt content in both the samples and the standards.

3. Sample Handling and Preservation

- 3.1 All bottles must be thoroughly cleansed and rinsed to remove soluble materials from containers.
  - 3.2 Oxidizing agents such as chlorine decompose most cyanides. Test a drop of the sample with potassium iodide-starch test paper (KI-Starch paper); a blue color indicates the need for treatment. Add ascorbic acid, a few crystals at a time, until a drop of sample produces no color on the indicator paper. Then add additional 0.6 g of ascorbic acid for each liter of sample volume.
  - 3.3 Samples are preserved with 2 mL of 10 N sodium hydroxide per liter of sample (pH > 12) at the time of collection.
  - 3.4 Samples must be stored at 4°C ( $\pm 2^\circ\text{C}$ ) and must be analyzed within the holding time specified in Exhibit D, Section II.
4. Interferences
- 4.1 Interferences are eliminated or reduced by using the distillation procedure.

4.2 Sulfides adversely affect the colorimetric procedures. If a drop of distillate on lead acetate test paper indicates the presence of sulfides, treat the sample with powdered cadmium carbonate. Yellow cadmium sulfide precipitates if the sample contains sulfide. Repeat this operation until a drop of the treated sample solution does not darken the lead acetate test paper. Filter the solution through a dry filter paper into a dry beaker, and from the filtrate, measure the sample to be used for analysis. Avoid a large excess of cadmium carbonate and long contact time in order to minimize loss by complexation or occlusion of cyanide on the precipitated material.

4.3 The presence of surfactants may cause the sample to foam during refluxing. If this occurs, the addition of an agent such as Dow Corning 544 antifoaming agent will prevent the foam from collecting in the condenser.

## 5. Apparatus

5.1 Midi reflux distillation apparatus as shown in figure 1.

5.2 Heating block - Capable of maintaining  $125^{\circ}\text{C} \pm 5^{\circ}\text{C}$ .

5.3 Auto analyzer system with accessories:

5.3.1 Sampler

5.3.2 Pump

5.3.3 Cyanide cartridge

5.3.4 Colorimeter with 50 mm flowcells and 580 nm filter

5.3.5 Chart recorder or data system.

5.4 Assorted volumetric glassware, pipets, and micropipets.

## 6. Reagents

6.1 Distillation and Preparation Reagents

6.1.1 Sodium hydroxide absorbing solution, and sample wash solution, 0.25 N. Dissolve 10.0 g NaOH in ASTM Type II water and dilute to one liter.

6.1.2 Magnesium chloride solution, 51% (w/v). Dissolve 510 g of  $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$  in ASTM Type II water and dilute to one liter.

6.1.3 Sulfuric acid, 50% (v/v). Carefully add a portion of concentrated  $\text{H}_2\text{SO}_4$  to an equal portion of ASTM Type II water.

6.1.4 Sodium hydroxide solution, 1.25 N. Dissolve 50 g of NaOH in ASTM Type II water and dilute to one liter.



## 6.2 Standards

- 6.2.1 Stock cyanide solution, 1000 mg/L CN. Dissolve 2.51 g of KCN and 2.0 g KOH in ASTM Type II water and dilute one liter. Standardize with 0.0192 N  $\text{AgNO}_3$ .
- 6.2.2 Intermediate cyanide standard solution, 10 mg/L CN. Dilute 1.0 mL of stock cyanide solution (6.2.1) plus 20 mL of 1.25 N NaOH solution (6.1.4) to 100 mL with ASTM Type II water. Prepare this solution at time of analysis.
- 6.2.3 Rhodamine indicator. Dissolve 20 mg of p-dimethylamino-benzal-rhodamine in 100 mL acetone.
- 6.2.4 Silver nitrate solution, 0.0192 N. Prepare by crushing approximately 5 g  $\text{AgNO}_3$  crystals and drying to a constant weight at  $104^\circ\text{C}$ . Weigh out 3.2647 g of dried  $\text{AgNO}_3$  and dissolve in ASTM Type II water. Dilute to one liter (1 mL corresponds to 1 mg CN).
- 6.2.5 Potassium chromate indicator solution. Dissolve 50 g  $\text{K}_2\text{CrO}_4$  in sufficient ASTM Type II water. Add silver nitrate solution until a definite red precipitate is formed. Let stand for at least 12 hours, filter, and dilute to one liter with ASTM Type II water.
- 6.2.6 Primary standard sodium chloride, 0.0141 N. Dissolve 824.1 mg NaCl (NBS-dried 20 minutes at  $104^\circ\text{C}$ ) in ASTM Type II water and dilute to one liter.
- 6.2.7 Sodium hydroxide solution, 0.1 N. Dissolve 4 g of NaOH in ASTM Type II water and dilute to one liter.

## 6.3 Semi-Automated Spectrophotometric Reagents

- 6.3.1 Phosphate buffer solution, 1 M. Dissolve 138 g of  $\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$  in ASTM Type II water and dilute to one liter. Add 0.5 mL of Brij-35 (available from Technicon). Store at  $4^\circ\text{C}$ .
- 6.3.2 Chloramine-T solution, 0.4% (w/v). Dissolve 0.4 g of chloramine-T in ASTM Type II water and dilute to 100 mL. Prepare fresh at time of analysis.
- 6.3.3 Color Reagent Solution, Pyridine barbituric acid color reagent solution. Prepare this solution in the hood. Transfer 15 g of barbituric acid into a one liter Erlenmeyer flask. Add about 100 mL of ASTM Type II water and swirl the flask to mix. Add 75 mL of pyridine and 15 mL concentrated HCL and mix until all the barbituric acid is dissolved. Dilute to one liter with ASTM Type II water and store at  $4^\circ\text{C}$ .

## 7. Procedure

### 7.1 Distillation

- 7.1.1 The procedure described here utilizes a midi distillation apparatus and requires a sample aliquot of 50 mLs or less for aqueous samples and one gram for solid materials. NOTE: All samples must initially be run undiluted (i.e., aqueous samples must first be run with a 50 mL aliquot and solid samples using a one gram sample). When the cyanide concentration exceeds the highest calibration standard, appropriate dilution (but not below the CRDL) and reanalysis of the sample is required. The dilution factor must be reported on Form XIV.
- 7.1.2 For aqueous samples: Pipet 50 mL of sample, or an aliquot diluted to 50 mL, into the distillation flask along with 2 or 3 boiling chips.
- 7.1.3 For solid samples: Weigh 1.0 g of sample (to the nearest 0.01 g) into the distillation flask and dilute to 50 mL with ASTM Type II water. Add 2 or 3 boiling chips.
- 7.1.4 Add 50 mL of 0.25 N NaOH (6.1.1) to the gas absorbing impinger.
- 7.1.5 Connect the boiling flask, condenser, and absorber in the train as shown in figure 2. The excess cyanide trap contains 0.5 N NaOH.
- 7.1.6 Turn on the vacuum and adjust the gang (Whitney) valves to give a flow of three bubbles per second from the impingers in each reaction vessel.
- 7.1.7 After five minutes of vacuum flow, inject 5 mL of 50% (v/v)  $\text{H}_2\text{SO}_4$  (6.1.3) through the top air inlet tube of the distillation head into the reaction vessel. Allow to mix for 5 minutes. (NOTE: The acid volume must be sufficient to bring the sample/solution pH to below 2.0.)
- 7.1.8 Add 2 mL of magnesium chloride solution (6.1.2) through the top air inlet tube of the distillation head into the reaction flask. Excessive foaming from samples containing surfactants may be quelled by the addition of another 2 mL of magnesium chloride solution.
- 7.1.9 Turn on the heating block and set for 123-125°C. Heat the solution to boiling, taking care to prevent solution backup by periodic adjustment of the vacuum flow.
- 7.1.10 After one and a half hours of refluxing, turn off the heat and continue the vacuum for an additional 15 minutes. The flasks should be cool at this time.
- 7.1.11 After cooling, close off the vacuum at the gang valve and remove the absorber. Seal the receiving solutions and store them at 4°C until analyzed. The solutions must be analyzed for cyanide within the 12 day holding time specified in Section II.

## 7.2 Semi-Automated Spectrophotometric Determination

- 7.2.1 Operating conditions: Because of the difference between various makes and models of satisfactory instruments, no detailed operating instructions can be provided. The analyst should follow the instructions provided by the manufacturer of the particular instrument. It is the responsibility of the analyst to verify that the instrument configuration and operating conditions used satisfy the analytical requirements and to maintain quality control data confirming instrument performance and analytical results.

The following general procedure applies to most semi-automated colorimeters. Set up the manifold and complete system per manufacturer's instructions. Allow the colorimeter and recorder warm up for at least 30 minutes prior to use. Establish a steady reagent baseline feeding ASTM Type II water through the sample line and appropriate reagents (6.3) through reagent lines. Adjust the baseline using the appropriate control on the colorimeter.

- 7.2.2 Prepare a minimum of 3 standards and a blank by pipetting suitable volumes of standard solution into 50 mL volumetric flasks. NOTE: One calibration standard must be at the Contract Required Detection Limit (CRDL).

As an example, standard solutions could be prepared as follows:

| <u>Total ug CN</u><br><u>standard solution</u> | <u>mL 10 mg/L CN</u> | <u>mL 0.05 N NaOH</u> |
|--|----------------------|-----------------------|
| 0.00   | 0.000                | 20                    |
| 0.10   | 0.010                | 20                    |
| 0.25   | 0.025                | 20                    |
| 0.50   | 0.050                | 20                    |
| 1.00   | 0.100                | 20                    |
| 2.00   | 0.200                | 20                    |
| 5.00   | 0.500                | 20                    |

- 7.2.2.1 Dilute standards to 50 mL using ASTM Type II water. It is not imperative that all standards be distilled in the same manner as the samples. At least one standard (mid-range) must be distilled and compared to similar values on the curve for each SDG to ensure the distillation technique is reliable. If the distilled standard does not agree within  $\pm 15\%$  of the undistilled standards, the operator must find and correct the cause of the error before proceeding.
- 7.2.3 Aspirate the highest calibration standard and adjust the colorimeter until the desired (maximum) signal-range is obtained.
- 7.2.4 Place calibration standards, blanks, control standards in the sampler tray, followed by distilled samples, distilled duplicates, distilled standards, distilled spikes, and distilled blanks.
- 7.2.5 Switch sample line from the ASTM Type II water to sampler, set the appropriate sampling rate and begin the analysis.

8. Calculations

## 8.1 Calculations for Semi-automated Colorimetric Determination

- 8.1.1 Prepare a standard curve by plotting absorbance (peak heights, determined visually or using a data system) of standards (y) versus cyanide concentration values (total ug CN/L) (x). Perform a linear regression analysis.
- 8.1.2 Multiply all distilled values by the standardization value to correct for the stock cyanide solution not being exactly 1000 mg/L (See 6.2.1).
- 8.1.3 Using the regression analysis equation, calculate sample receiving solution concentrations from the calibration curve.
- 8.1.4 Calculate the cyanide of aqueous samples in ug/L of original sample, as follows:

$$\text{CN, ug/L} = \frac{A \times D \times F}{B}$$

- where:
- A - ug/L CN of sample from regression analysis
  - B - Liter of original sample for distillation (0.050 L) (See 7.1.2)
  - D - any dilution factor necessary to bracket sample value within standard values
  - F - sample receiving solution volume (0.050 L)

The minimum value that can be substituted for A is 10 ug/L.

- 8.1.5 Calculate the cyanide of solid samples in mg/kg of original sample, as follows:
- 8.1.5.1 A separate determination of percent solids must be performed (See Part F).
- 8.1.5.2 The concentration of cyanide in the sample is determined as follows:

$$\text{CN, mg/kg} = \frac{A \times D \times F}{B \times E}$$

- where:
- A - ug/L CN of sample from regression analysis curve
  - B - wet weight of original sample in g (See 7.1.3)



D - any dilution factor necessary to bracket sample value within standard values

E - % solids (See Part F)/100.

F - sample receiving solution volume (0.050 L)

The minimum value that can be substituted for A is 10 ug/L

PART F - PERCENT SOLIDS DETERMINATION PROCEDURE

1. Immediately following the weighing of the sample to be processed for analysis (see Section III, Part B- Soil/Sediment Sample Preparation), add 5-10 g of sample to a tared weighing dish. Weigh and record the weight to the nearest 0.01 g.
2. Place weighing dish plus sample, with the cover tipped to allow for moisture escape, in a drying oven maintained at 103-105°C. Sample handling and drying should be conducted in a well-ventilated area.
3. Dry the sample overnight (12-24 hours) but no longer than 24 hours. If dried less than 12 hours, it must be documented that constant weight was attained.\* Remove the sample from the oven and cool in a dessicator with the weighing dish cover in place before weighing. Weigh and record weight to nearest 0.01 g. Do not analyze the dried sample.
4. Duplicate percent solids determinations are required at the same frequency as are other analytical determinations. Duplicate results are to be recorded on FORM VI-IN.
5. For the duplicate percent solids determination, designate one sample aliquot as the "original" sample and the other aliquot as the "duplicate" sample. Calculate dry weight using the results of the "original" sample aliquot.
6. Calculate percent solids by the formula below. The value thus obtained will be reported on the appropriate FORM I-IN and, where applicable, FORM VI-IN. This value will be used for calculating analytical concentration on a dry weight basis.

$$\% \text{ Solids} = \frac{\text{Sample Dry Weight}}{\text{Sample Wet Weight}} \times 100$$

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\*For the purpose of paragraph 3, drying time is defined as the elapsed time in the oven; thus raw data must record time in and out of the oven to document the 12 hour drying time minimum. In the event it is necessary to demonstrate the attainment of constant weight, data must be recorded for a minimum of two repetitive weigh/dry/dessicate/weigh cycles with a minimum of 1 hour drying time in each cycle. Constant weight would be defined as a loss in weight of no greater than 0.01 g between the start weight and final weight of the last cycle.

PART G - ALTERNATE METHODS (CATASTROPHIC ICP FAILURE)<sup>+</sup>

| <u>Analyte</u>                             | <u>Page No.</u> |
|--|-----------------|
| Aluminum - Method 202.2 CLP-M*, Furnace AA | D-92            |
| Barium - Method 208.2 CLP-M, Furnace AA    | D-93            |
| Cobalt - Method 219.2 CLP-M, Furnace AA    | D-94            |
| Copper - Method 220.2 CLP-M, Furnace AA    | D-95            |
| Iron - Method 236.2 CLP-M, Furnace AA      | D-96            |
| Manganese - Method 243.2 CLP-M, Furnace AA | D-97            |
| Nickel - Method 249.2 CLP-M, Furnace AA    | D-98            |
| Vanadium - Method 286.2 CLP-M, Furnace AA  | D-99            |
| Zinc - Method 289.2 CLP-M, Furnace AA      | D-100           |
| Aluminum - Method 202.1 CLP-M, Flame AA    | D-102           |
| Antimony - Method 204.1 CLP-M, Flame AA    | D-104           |
| Barium - Method 208.1 CLP-M, Flame AA      | D-105           |
| Beryllium - Method 210.1 CLP-M, Flame AA   | D-106           |
| Cadmium - Method 213.1 CLP-M, Flame AA     | D-107           |
| Chromium - Method 218.1 CLP-M, Flame AA    | D-108           |
| Cobalt - Method 219.1 CLP-M, Flame AA      | D-109           |
| Copper - Method 220.1 CLP-M, Flame AA      | D-110           |
| Iron - Method 236.1 CLP-M, Flame AA        | D-111           |
| Lead - Method 239.1 CLP-M, Flame AA        | D-112           |
| Manganese - Method 243.1 CLP-M, Flame AA   | D-113           |
| Nickel - Method 249.1 CLP-M, Flame AA      | D-114           |
| Silver - Method 272.1 CLP-M, Flame AA      | D-115           |
| Thallium - Method 279.1 CLP-M, Flame AA    | D-117           |
| Vanadium - Method 286.1 CLP-M, Flame AA    | D-118           |
| Zinc - Method 289.1 CLP-M, Flame AA        | D-119           |

<sup>+</sup>Furnace AA Methods are from "Methods for Chemical Analysis of Water and Wastes", (EPA-600/4-79-02), March 1979, as modified for use in the Contract Laboratory Program (CLP). Flame AA (Flame Technique) Methods are from "Interim Methods for the Sampling and Analysis of Priority Pollutants in Sediments and Fish Tissue," USEPA Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, August 1977, Revised October 1980, as modified for use in the CLP.

\*CLP-M Modified for the Contract Laboratory Program.

CONDITIONS FOR USE OF ALTERNATE METHODS

The methods contained in Part G may be used only if all of the following conditions are met:

- 1) Catastrophic failure of ICP occurs,
- 2) Administrative Project Officer authorization for use of alternate methods is granted, and
- 3) The IDLs for the instrumentation have been determined, as per Exhibit E, within the current calendar quarter.



## ALUMINUM\*

## Method 202.2 CLP-M\*\* (Atomic Absorption, Furnace Technique)

Optimum Concentration Range: 20-200 ug/L

Approximate Detection Limit: 3 ug/L

Preparation of Standard Solution

1. Stock solution: Prepare as described under AA Flame Technique (Method 202.1 CLP-M).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. These solutions are also to be used for "standard additions".
3. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrument Parameters (General)

1. Drying Time and Temp: 30 sec @ 125°C.
2. Ashing Time and Temp: 30 sec @ 1300°C.
3. Atomizing Time and Temp: 10 sec @ 2700°C.
4. Purge Gas Atmosphere: Argon
5. Wavelength: 309.3 nm
6. Other operating parameters should be set as specified by the particular instrument manufacturer.

Notes

1. The above concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20 uL injection, continuous flow purge gas and non-pyrolytic graphite and are to be used as guidelines only.
2. Background correction is required.
3. It has been reported that chloride ion and that nitrogen used as a purge gas suppress the aluminum signal. Therefore the use of halide acids and nitrogen as a purge gas should be avoided.
4. For every sample analyzed, verification is necessary to determine that method of standard addition is not required (Exhibit E).
5. If method of standard addition is required, follow the procedure given in Exhibit E.

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\*This method may only be used under specified conditions.

\*\*CLP-M Modified for the Contract Laboratory Program.

## BARIUM\*

## Method 208.2 CLP-M\*\* (Atomic Absorption, Furnace Technique)

Optimum Concentration Range: 10-200 ug/L  
Approximate Detection Limit: 2 ug/L

Preparation of Standard Solution

1. Stock solution: Prepare as described under AA Flame Technique (Method 208.1 CLP-M).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. These solutions are also to be used for "standard additions".
3. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrument Parameters (General)

1. Drying Time and Temp: 30 sec @ 125°.
2. Ashing Time and Temp: 30 sec @ 1200°C.
3. Atomizing Time and Temp: 10 sec @ 2800°C.
4. Purge Gas Atmosphere: Argon
5. Wavelength: 553.6 nm
6. Other operating parameters should be set as specified by the particular instrument manufacturer.

Notes

1. The above concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20 uL injection, continuous flow purge gas and pyrolytic graphite and are to be used as guidelines only.
2. The use of halide acid should be avoided.
3. Because of possible chemical interaction, nitrogen should not be used as a purge gas.
4. For every sample analyzed, verification is necessary to determine that method of standard addition is not required (see Exhibit E).
5. If method of standard addition is required, follow the procedure given in Exhibit E.

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\*This method may only be used under specified conditions.

\*\*CLP-M Modified for the Contract Laboratory Program.

## COBALT\*

## Method 219.2 CLP-M\*\* (Atomic Absorption, Furnace Technique)

Optimum Concentration Range: 5-100 ug/L

Approximate Detection Limit: 1 ug/L

Preparation of Standard Solution

1. Stock solution: Prepare as described under AA Flame Technique (Method 219.1 CLP-M).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. These solutions are also to be used for "standard additions".
3. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrument Parameters (General)

1. Drying Time and Temp: 30 sec @ 125°C.
2. Ashing Time and Temp: 30 sec @ 900°C.
3. Atomizing Time and Temp: 10 sec @ 2700°C.
4. Purge Gas Atmosphere: Argon
5. Wavelength: 240.7 nm
6. Other operating parameters should be set as specified by the particular instrument manufacturer.

Notes

1. The above concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20 uL injection, continuous flow purge gas and non-pyrolytic graphite and are to be used as guidelines only. Smaller size furnace devices or those employing faster rates of atomization c furnace using lower atomization temperatures for shorter time periods than the above recommended settings.
2. The use of background correction is required.
3. Nitrogen may also be used as the purge gas but with reported low sensitivity.
4. For every sample analyzed, verification is necessary to determine that method of standard addition is not required (see Exhibit E).
5. If method of standard addition is required, follow the procedure given in Exhibit E.

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\*This method may only be used under specified conditions.

\*\*CLP-M Modified for the Contract Laboratory Program.

## COPPER\*

## Method 220.2 CLP-M\*\* (Atomic Absorption, Furnace Technique)

Optimum Concentration Range: 5-100 ug/L  
Approximate Detection Limit: 1 ug/L

Preparation of Standard Solution

1. Stock solution: Prepare as described under AA Flame Technique (Method 220.1 CLP-M).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. These solutions are also to be used for "standard additions".
3. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrument Parameters (General)

1. Drying Time and Temp: 30 sec @ 125°C.
2. Ashing Time and Temp: 30 sec @ 900°C.
3. Atomizing Time and Temp: 10 sec @ 2700°C.
4. Purge Gas Atmosphere: Argon
5. Wavelength: 324.7 nm
6. Other operating parameters should be set as specified by the particular instrument manufacturer.

Notes

1. The above concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20 uL injection, continuous flow purge gas and non-pyrolytic graphite and are to be used as guidelines only. Smaller size furnace devices or those employing faster rates of atomization can be operated using lower atomization temperatures for shorter time periods than the above recommended settings.
2. Background correction is required.
3. Nitrogen may also be used as the purge gas.
4. For every sample analyzed, verification is necessary to determine that method of standard addition is not required (see Exhibit E).
5. If method of standard addition is required, follow the procedure given in Exhibit E.

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\*This method may only be used under specified conditions.

\*\*CLP-M Modified for the Contract Laboratory Program.



## IRON\*

## Method 236.2 CLP-M\*\* (Atomic Absorption, Furnace Technique)

Optimum Concentration Range: 5-100 ug/L  
Approximate Detection Limit: 1 ug/L

Preparation of Standard Solution

1. Stock solution: Prepare as described under AA Flame Technique (Method 236.1-CLP-M).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. These solutions are also to be used for "standard additions".
3. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrument Parameters (General)

1. Drying Time and Temp: 30 sec @ 125°C.
2. Ashing Time and Temp: 30 sec @ 1000°C.
3. Atomizing Time and Temp: 10 sec @ 2700°C.
4. Purge Gas Atmosphere: Argon
5. Wavelength: 248.3 nm
6. Other operating parameters should be set as specified by the particular instrument manufacturer.

Notes

1. The above concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20 uL injection, continuous flow purge gas and non-pyrolytic graphite and are to be used as guidelines only. Smaller size furnace devices or those employing faster rates of atomization can be operated using lower atomization temperatures for shorter time periods than the above recommended settings.
2. The use of background correction is required.
3. Nitrogen may also be used as the purge gas.
4. For every sample analyzed, verification is necessary to determine that method of standard addition is not required (see Exhibit E).
5. If method of standard addition is required, follow the procedure given in Exhibit E.

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\*This method may only be used under specified conditions.

\*\*CLP-M Modified for the Contract Laboratory Program.

## MANGANESE\*

## Method 243.2 CLP-M\*\* (Atomic Absorption, Furnace Technique)

Optimum Concentration Range: 1-30 ug/L  
Approximate Detection Limit: 0.2 ug/L

Preparation of Standard Solution

1. Stock solution: Prepare as described under AA Flame Technique (Method 243.1 CLP-M).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. These solutions are also to be used for "standard additions".
3. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrument Parameters (General)

1. Drying Time and Temp: 30 sec @ 125°C.
2. Ashing Time and Temp: 30 sec @ 1000°C.
3. Atomizing Time and Temp: 10 sec @ 2700°C.
4. Purge Gas Atmosphere: Argon
5. Wavelength: 279.5 nm
6. Other operating parameters should be set as specified by the particular instrument manufacturer.

Notes

1. The above concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20 uL injection, continuous flow purge gas and non-pyrolytic graphite and are to be used as guidelines only. Smaller size furnace devices or those employing faster rates of atomization can be operated using lower atomization temperatures for shorter time periods than the above recommended settings.
2. The use of background correction is required.
3. Nitrogen may also be used as the purge gas.
4. For every sample analyzed, verification is necessary to determine that method of standard addition is not required (see Exhibit E).
5. If method of standard addition is required, follow the procedure given in Exhibit E.

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\*This method may only be used under specified conditions.

\*\*CLP-M Modified for the Contract Laboratory Program.

## NICKEL\*

## Method 249.2 CLP-M\*\* (Atomic Absorption, Furnace Technique)

Optimum Concentration Range: 5-100 ug/L

Approximate Detection Limit: 1 ug/L

Preparation of Standard Solution

1. Stock solution: Prepare as described under AA Flame Technique (Method 249.1 CLP-M).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. These solutions are also to be used for "standard additions".
3. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrument Parameters (General)

1. Drying Time and Temp: 30 sec @ 125°C.
2. Ashing Time and Temp: 30 sec @ 900°C.
3. Atomizing Time and Temp: 10 sec @ 2700°C.
4. Purge Gas Atmosphere: Argon
5. Wavelength: 232.0 nm
6. Other operating parameters should be set as specified by the particular instrument manufacturer.

Notes

1. The above concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20 uL injection, continuous flow purge gas and non-pyrolytic graphite and are to be used as guidelines only. Smaller size furnace devices or those employing faster rates of atomization can be operated using lower atomization temperatures for shorter time periods than the above recommended settings.
2. The use of background correction is required.
3. Nitrogen may also be used as the purge gas.
4. For every sample analyzed, verification is necessary to determine that method of standard addition is not required (see Exhibit E).
5. If method of standard addition is required, follow the procedure given in Exhibit E.

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\*This method may only be used under specified conditions.

\*\*CLP-M Modified for the Contract Laboratory Program.

## VANADIUM\*

## Method 286.2 CLP-M\*\* (Atomic Absorption, Furnace Technique)

Optimum Concentration Range: 10-200 ug/L

Approximate Detection Limit: 4 ug/L

Preparation of Standard Solution

1. Stock solution: Prepare as described under AA Flame Technique (Method 286.1 CLP-M).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. These solutions are also to be used for "standard additions."
3. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrument Parameters (General)

1. Drying Time and Temp: 30 sec @ 125°C.
2. Ashing Time and Temp: 30 sec @ 1400°C.
3. Atomizing Time and Temp: 15 sec @ 2800°C.
4. Purge Gas Atmosphere: Argon
5. Wavelength: 318.4 nm
6. Other operating parameters should be set as specified by the particular instrument manufacturer.

Notes

1. The above concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20 uL injection, continuous flow purge gas and pyrolytic graphite and are to be used as guidelines only. Smaller size furnace devices or those employing faster rates of atomization can be operated using lower atomization temperatures for shorter time periods than the above recommended settings.
2. The use of background correction is required.
3. Because of possible chemical interaction, nitrogen should not be used as the purge gas.
4. For every sample analyzed, verification is necessary to determine that method of standard addition is not required (see Exhibit E).
5. If method of standard addition is required, follow the procedure given in Exhibit E.

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\*This method may only be used under specified conditions.

\*\*CLP-M Modified for the Contract Laboratory Program.



## ZINC\*

Method 289.2 CLP-M\*\* (Atomic Absorption, Furnace Technique)

Optimum Concentration Range: 0.2-4 ug/L

Approximate Detection Limit: 0.05 ug/L

Preparation of Standard Solution

1. Stock solution: Prepare as described under AA Flame Technique (Method 289.1 CLP-M).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. These solutions are also to be used for "standard additions".
3. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrument Parameters (General)

1. Drying Time and Temp: 30 sec @ 125°C.
2. Ashing Time and Temp: 30 sec @ 400°C.
3. Atomizing Time and Temp: 10 sec @ 2500°C.
4. Purge Gas Atmosphere: Argon
5. Wavelength: 213.9 nm
6. Other operating parameters should be set as specified by the particular instrument manufacturer.

Notes

1. The above concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20 uL injection, continuous flow purge gas and non-pyrolytic graphite and are to be used as guidelines only. Smaller size furnace devices or those employing faster rates of atomization can be operated using lower atomization temperatures for shorter time periods than the above recommended settings.
2. The use of background correction is required.
3. Nitrogen may also be used as the purge gas.
4. The analysis of zinc by the graphite furnace is extremely sensitive and very subject to contamination from the work area, reagents, and pipette tips. Since all these factors affect the precision and accuracy, zinc should be analyzed by the direct aspiration procedure whenever possible.

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\*This method may only be used under specified conditions.

\*\*CLP-M Modified for the Contract Laboratory Program.

5. For every sample analyzed, verification is necessary to determine that method of standard addition is not required (see Exhibit E).
6. If method of standard addition is required, follow the procedure given in Exhibit E.

## ALUMINUM\*

## Method 202.1 CLP-M\*\* (Atomic Absorption, Flame Technique)

Optimum Concentration Range: 5-50 mg/L using a wavelength of 309.3 nm

Sensitivity: 1 mg/L

Approximate Detection Limit: 0.1 mg/L

Preparation of Standard Solution

1. Stock Solution: Carefully weigh 1,000 g of aluminum metal analytical reagent grade). Add 15 mL of conc. HCl and 5 mL conc. HNO<sub>3</sub> to the metal, cover the beaker and warm gently. When solution is complete, transfer quantitatively to a liter volumetric flask and make up to volume with deionized distilled water. 1 mL = 1 mg Al (1000 mg/L).
2. Potassium Chloride Solution: Dissolve 95 g potassium chloride (KCl) in deionized distilled water and make up to 1 liter.
3. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation. To each 100 mL of standard and sample alike add 2.0 mL potassium chloride solution.

Instrument Parameters (General)

1. Aluminum hollow cathode lamp
2. Wavelength: 309.3 nm
3. Fuel: Acetylene
4. Oxidant: Nitrous oxide
5. Type of flame: Fuel rich

Interferences

1. Aluminum is partially ionized in the nitrous oxide-acetylene flame. This problem may be controlled by the addition of an alkali metal (potassium, 1000 ug/mL) to both sample and standard solutions.

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\*This method may only be used under specified conditions.

\*\*CLP-M Modified for the Contract Laboratory Program.

Notes

1. The following may also be used:

- 308.2 nm Relative Sensitivity 1
- 396.2 nm Relative Sensitivity 2
- 394.4 nm Relative Sensitivity 2.5

2. For concentrations of aluminum below 0.3 mg/L, use of Furnace Technique (Method 202.2 CLP-M) is recommended.



## ANTIMONY\*

## Method 204.1 CLP-M\*\* (Atomic Absorption, Flame Technique)

Optimum Concentration Range: 1-40 mg/L using a wavelength of 217.6 nm

Sensitivity: 0.5 mg/L

Approximate Detection Limit: 0.2 mg/L

Preparation of Standard Solution

1. Stock Solution: Carefully weigh 2.7426 g of antimony potassium tartrate (analytical reagent grade) and dissolve in deionized distilled water. Dilute to 1 liter with deionized distilled water. 1 mL = 1 mg Sb (1000 mg/L).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrumental Parameters (General)

1. Antimony hollow cathode lamp
2. Wavelength: 217.6 nm
3. Fuel: Acetylene
4. Oxidant: Air
5. Type of flame: Fuel lean

Interferences

1. In the presence of lead (1000 mg/L), a special interference may occur at the 217.6 nm resonance line. In this case the 231.1 nm antimony line should be used.
2. Increasing acid concentrations decrease antimony absorption. To avoid this effect, the acid concentration in the samples and in the standards must be matched.

Notes

1. For concentrations of antimony below 0.35 mg/L, use of the Furnace Technique (Method 204.2 CLP-M) is recommended.

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\*This method may only be used under specified conditions.

\*\*CLP-M Modified for the Contract Laboratory Program.

## BARIUM\*

## Method 208.1 CLP-M\*\* (Atomic Absorption, Flame Technique)

Optimum Concentration Range: 1-20 mg/L using a wavelength of 553.6 nm

Sensitivity: 0.4 mg/L

Approximate Detection Limit: 0.1 mg/L

Preparation of Standard Solution

1. Stock Solution: Dissolve 1.7787 g of barium chloride ( $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ , analytical reagent grade) in deionized distilled water and dilute to liter. 1 mL = 1 mg Ba (1000 mg/L).
2. Potassium chloride solution: Dissolve 95 g potassium chloride, KCl, in deionized distilled water and make up to 1 liter.
3. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. To each 100 mL of standard and sample alike add 2.0 mL potassium chloride solution. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrumental Parameters (General)

1. Barium hollow cathode lamp
2. Wavelength: 553.6 nm
3. Fuel: Acetylene
4. Oxidant: Nitrous oxide
5. Type of flame: Fuel rich

Interferences

1. The use of a nitrous oxide-acetylene flame virtually eliminates chemical interference; however, barium is easily ionized in this flame and potassium must be added (1000 mg/L) to standards and samples alike to control this effect.
2. If the nitrous oxide flame is not available and acetylene-air is used, phosphate, silicon and aluminum will severely depress the barium absorbance. This may be overcome by the addition of 2000 mg/L lanthanum.

Notes

1. For concentrations of barium below 0.2 mg/L, use of the Furnace Technique (Method 208.2 CLP-M) is recommended.

\*This method may only be used under specified conditions.

\*\*CLP-M Modified for the Contract Laboratory Program.

## BERYLLIUM\*

## Method 210.1 CLP-M\*\* (Atomic Absorption, Flame Technique)

Optimum Concentration Range: 0.052 mg/L using a wavelength of 234.9 nm

Sensitivity: 0.025 mg/L

Approximate Detection Limit: 0.005 mg/L

Preparation of Standard Solution

1. Stock Solution: Dissolve 11.6586 g of beryllium sulfate,  $\text{BeSO}_4$ , in deionized distilled water containing 2 mL conc. nitric acid and dilute to 1 liter. 1 mL = 1 mg Be (1000 mg/L).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. The calibration standards should be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrumental Parameters (General)

1. Beryllium hollow cathode lamp
2. Wavelength: 234.9 nm
3. Fuel: Acetylene
4. Oxidant: Nitrous oxide
5. Type of flame: Fuel rich

Interferences

1. Sodium and silicon at concentrations in excess of 1000 mg/L have been found to severely depress the beryllium absorbance.
2. Bicarbonate ion is reported to interfere; however, its effect is eliminated when samples are acidified to a pH of 1.5.
3. Aluminum at concentrations of 500 ug/L is reported to depress the sensitivity of beryllium [Spectrochim Acta 22, 1325 (1966)].

Notes

1. For concentrations of beryllium below 0.02 mg/L, use of the Furnace Technique (Method 210.2 CLP-M) is recommended.

\*This method may only be used under specified conditions.

\*\*CLP-M Modified for the Contract Laboratory Program.

## CADMIUM\*

## Method 213.1 CLP-M\*\* (Atomic Absorption, Flame Technique)

Optimum Concentration Range: 0.052 mg/L using a wavelength of 228.8 nm

Sensitivity: 0.025 mg/L

Approximate Detection Limit: 0.005 mg/L

Preparation of Standard Solution

1. Stock Solution: Carefully weigh 2.282 g of cadmium sulfate ( $3\text{CdSO}_4 \cdot 8\text{H}_2\text{O}$ , analytical reagent grade) and dissolve in deionized distilled water. Make up to 1 liter with deionized distilled water. 1 mL = 1 mg Cd (1000 mg/L).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrumental Parameters (General)

1. Cadmium hollow cathode lamp
2. Wavelength: 228.8 nm
3. Fuel: Acetylene
4. Oxidant: Air
5. Type of flame: Oxidizing

Notes

1. For concentrations of cadmium below 20 ug/L, use of the Furnace Technique, Method 213.2 CLP-M is recommended.

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\*This method may only be used under specified conditions.

\*\*CLP-M Modified for the Contract Laboratory Program.



## CHROMIUM\*

## Method 218.1 CLP-M\*\* (Atomic Absorption, Flame Technique)

Optimum Concentration Range: 0.5-10 mg/L using a wavelength of 357.9 nm  
Sensitivity: 0.25 mg/L  
Approximate Detection Limit: 0.05 mg/L

Preparation of Standard Solution

Stock Solution: Dissolve 1.923 g of chromium trioxide ( $\text{CrO}_3$ , reagent grade) in deionized distilled water. When solution is complete, acidify with redistilled  $\text{HNO}_3$  and dilute to 1 liter with deionized distilled water. 1 mL = 1 mg Cr (1000 mg/L).

Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrument Parameters (General)

1. Chromium hollow cathode lamp
2. Wavelength: 357.9 nm
3. Fuel: Acetylene
4. Oxidant: Nitrous oxide
5. Type of flame: Fuel rich

Notes

The following wavelengths may also be used:

- 359.3 nm Relative Sensitivity 1.4
- 425.4 nm Relative Sensitivity 2
- 427.5 nm Relative Sensitivity 3
- 428.9 nm Relative Sensitivity 4

The fuel rich air-acetylene flame provides greater sensitivity but is subject to chemical and matrix interference from iron, nickel, and other metals. If the analysis is performed in a lean flame the interference can be lessened but the sensitivity will also be reduced.

The suppression of both Cr (III) and Cr (VI) absorption by most interfering ions in fuel rich air-acetylene flames is reportedly controlled by the addition of 1% ammonium bifluoride in 0.2% sodium sulfate [Talanta 20, 631 (1973)]. A 1% oxine solution is also reported to be useful.

For concentrations of chromium between 50 and 200 ug/L where the air-acetylene flame cannot be used or for concentrations below 50 ug/L, use of the Furnace Technique (Method 218.2 CLP-M) is recommended.

This method may only be used under specified conditions.

CLP-M Modified for the Contract Laboratory Program.

## COBALT\*

## Method 219.1\*\* CLP-M (Atomic Absorption, Flame Technique)

Optimum Concentration Range: 0.5-5 mg/L using a wavelength of 240.7 nm

Sensitivity: 0.2 mg/L

Approximate Detection Limit: 0.05 mg/L

Preparation of Standard Solution

1. Stock Solution: Dissolve 4.307 g of cobaltous chloride ( $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$  analytical reagent grade), in deionized distilled water. Add 10 mL of concentrated nitric acid and dilute to 1 liter with deionized distilled water. 1 mL = 1 mg Co (1000 mg/L).
2. Prepare dilutions of the stock cobalt solution to be used as calibration standards at the time of analysis. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrument Parameters (General)

1. Cobalt hollow cathode lamp
2. Wavelength: 240.7 nm
3. Fuel: Acetylene
4. Oxidant: Air
5. Type of flame: Oxidizing

Notes

1. For concentrations of cobalt below 100 ug/L use of the Furnace Technique (Method 219.2 CLP-M) is recommended.

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\*This method may only be used under specified conditions.

\*\*CLP-M Modified for the Contract Laboratory Program.

## COPPER\*

## Method 220.1 CLP-M\*\* (Atomic Absorption, Flame Technique)

Optimum Concentration Range: 0.2-5 mg/L using a wavelength of 324.7 nm

Sensitivity: 0.1 mg/L

Approximate Detection Limit: 0.02 mg/L

Preparation of Standard Solution

1. Stock Solution: Carefully weigh 100 g of electrolyte copper (analytical reagent grade). Dissolve in 5 mL redistilled  $\text{HNO}_3$  and make up to 1 liter with deionized distilled water. Final concentration is 1 mg Cu per mL (1000 mg/L).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrumental Parameters (General)

1. Copper hollow cathode lamp
2. Wavelength: 324.7 nm
3. Fuel: Acetylene
4. Oxidant: Air
5. Type of flame: Oxidizing

Notes

1. For concentrations of copper below 50 ug/L use of the Furnace Technique (Method 220.2 CLP-M) is recommended.
2. Numerous absorption lines are available for the determination of copper. By selecting a suitable absorption wavelength, copper samples may be analyzed over a very wide range of concentrations. The following lines may be used:  
  
327.4 nm Relative Sensitivity 2  
216.5 nm Relative Sensitivity 7  
222.5 nm Relative Sensitivity 20

\*This method may only be used under specified conditions.

\*\*CLP-M Modified for the Contract Laboratory Program.

## IRON\*

## Method 236.1 CLP-M\*\* (Atomic Absorption, Flame Technique)

Optimum Concentration Range: 0.3-5 mg/L using a wavelength of 248.3 nm

Sensitivity: 0.12 mg/L

Approximate Detection Limit: 0.03 mg/L

Preparation of Standard Solution

1. Stock Solution: Carefully weigh 1.000 g of pure iron wire (analytical reagent grade) and dissolve in 5 mL redistilled  $\text{HNO}_3$ , warming if necessary. When solution is complete, make up to 1 liter with deionized distilled water. 1 mL = 1 mg Fe (1000 mg/L).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrumental Parameters (General)

1. Iron hollow cathode lamp
2. Wavelength: 248.3 nm
3. Fuel: Acetylene
4. Oxidant: Air
5. Type of flame: Oxidizing

Notes

1. The following wavelengths may also be used:  
248.8 nm Relative Sensitivity 2  
271.9 nm Relative Sensitivity 4  
302.1 nm Relative Sensitivity 5  
252.7 nm Relative Sensitivity 6  
372.0 nm Relative Sensitivity 10
2. For concentrations of iron below 0.05 mg/L use of the Furnace Technique (Method 236.2 CLP-M) is recommended.

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\*This method may only be used under specified conditions.

\*\*CLP-M Modified for the Contract Laboratory Program.



## LEAD\*

## Method 239.1 CLP-M\*\* (Atomic Absorption, Flame Technique)

Optimum Concentration Range: 1-20 mg/L using a wavelength of 283.3 nm

Sensitivity: 0.5 mg/L

Approximate Detection Limit: 0.1 mg/L

Preparation of Standard Solution

1. Stock Solution: Carefully weigh 1.599 g of lead nitrate,  $\text{Pb}(\text{NO}_3)_2$  (analytical reagent grade), and dissolve deionized distilled water. When solution is complete acidify with 10 mL redistilled  $\text{HNO}_3$  and dilute to 1 liter with deionized distilled water. 1 mL = 1 mg Pb (1000 mg/L).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrumental Parameters (General)

1. Lead hollow cathode lamp
2. Wavelength: 283.3 nm
3. Fuel: Acetylene
4. Oxidant: Air
5. Type of flame: Oxidizing

Notes

1. The analysis of this metal is exceptionally sensitive to turbulence and absorption bands in the flame. Therefore, some care should be taken to position the light beam in the most stable, center portion of the flame. To do this, first adjust the burner to maximize the absorbance reading with a lead standard. Then, aspirate a water blank and make minute adjustments in the burner alignment to minimize the signal.
2. The concentrations of lead below 200 ug/L use of the Furnace Technique (Method 239.2 CLP-M) is recommended.
3. The following wavelengths may also be used:  
217.0 nm Relative Sensitivity 0.4  
261.4 nm Relative Sensitivity 10

\*This method may only be used under specified conditions.

\*\*CLP-M Modified for the Contract Laboratory Program.

## MANGANESE\*

## Method 243.1 CLP-M\*\* (Atomic Absorption, Flame Technique)

Optimum Concentration Range: 0.1-3 mg/L using a wavelength of 279.5 nm

Sensitivity: 0.05 mg/L

Approximate Detection Limit: 0.01 mg/L

Preparation of Standard Solution

1. Stock Solution: Carefully weigh 1.000 g of manganese metal (analytical reagent grade), and dissolve in 10 mL redistilled  $\text{HNO}_3$ . When solution is complete, dilute to 1 liter with 1% (v/v) HCl. 1 mL = 1 mg Mn (1000 mg/L).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrumental Parameters (General)

1. Manganese hollow cathode lamp
2. Wavelength: 279.5 nm
3. Fuel: Acetylene
4. Oxidant: Air
5. Type of flame: Oxidizing

Notes

1. For concentrations of manganese below 25 ug/L, use of the Furnace Technique (Method 243.2 CLP-M) is recommended.
2. The following line may also be used: 403.1 nm Relative Sensitivity 10.

\*This method may only be used under specified conditions.

\*\*CLP-M Modified for the Contract Laboratory Program.

## NICKEL\*

## Method 249.1 CLP-M\*\* (Atomic Absorption, Flame Technique)

Optimum Concentration Range: 0.3-5 mg/L using a wavelength of 232.0 nm

Sensitivity: 0.15 mg/L

Approximate Detection Limit: 0.04 mg/L

Preparation of Standard Solution

1. Stock Solution: Dissolve 4.953 g of nickel nitrate,  $\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$  (analytical reagent grade) in deionizing distilled water. Add 10 mL of conc. nitric acid and dilute to 1 liter deionized distilled water. 1 mL = 1 mg Ni (1000 mg/L).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. The calibration standards should be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrumental Parameters (General)

1. Nickel hollow cathode lamp
2. Wavelength: 232.0 nm
3. Fuel: Acetylene
4. Oxidant: Air
5. Type of flame: Oxidizing

Interferences

1. The 352.4 nm wavelength is less susceptible to spectral interference and may be used. The calibration curve is more linear at this wavelength; however, there is some loss of sensitivity.

Notes

1. For concentrations of nickel below 100 ug/L, use of the Furnace Technique (Method 249.2 CLP-M) is recommended.

\*This method may only be used under specified conditions.

\*\*CLP-M Modified for the Contract Laboratory Program.

## SILVER\*

## Method 272.1 CLP-M\*\* (Atomic Absorption, Flame Technique)

Optimum Concentration Range: 0.1-4 mg/L using a wavelength of 328.1 nm

Sensitivity: 0.06 mg/L

Approximate Detection Limit: 0.01 mg/L

Preparation of Standard Solution

1. Stock Solution: Dissolve 1.575 g of  $\text{AgNO}_3$ , (analytical reagent grade) in deionized distilled water, add 10 mL conc.  $\text{HNO}_3$  and make up to 1 liter. 1 mL = 1 mg Ag (1000 mg/L).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.
3. Iodine Solution, 1 N: Dissolve 20 grams of potassium iodide, KI (analytical reagent grade) in 50 mL of deionized distilled water, add 12.7 grams of iodine,  $\text{I}_2$ , (analytical reagent grade) and dilute to 100 mL. Store in a brown bottle.
4. Cyanogen Iodide (CNI) Solution: To 50 mL of deionized distilled water add 4.0 mL conc.  $\text{NH}_4\text{OH}$ , 6.5 grams KCN, and 5.0 mL of 1.0 N  $\text{I}_2$  solution. Mix and dilute to 100 mL with deionized distilled water. Fresh solution should be prepared every two weeks.(1)

Instrumental Parameters (General)

1. Silver hollow cathode lamp
2. Wavelength: 328.1 nm
3. Fuel: Acetylene
4. Oxidant: Air
5. Type of flame: Oxidizing

Notes

1. For concentrations of silver below 30 ug/L, use of the Furnace Technique (Method 272.2 CLP-M) is recommended.
2. Silver nitrate standards are light sensitive. Dilutions of the stock should be discarded after use as concentrations below 10 mg/L are not stable over long periods of time.

\*This method may only be used under specified conditions.

\*\*CLP-M Modified for the Contract Laboratory Program.



3. If absorption to container walls or the formation of AgCl is suspected, make the sample basic using conc.  $\text{NH}_4\text{OH}$  and add 1 mL of (CNI) solution per 100 mL of sample. Mix the sample and allow to stand for 1 hour before proceeding with the analysis.(1)
4. The 338.2 nm wavelength may also be used. This has a relative sensitivity of 2.

## THALLIUM\*

## Method 279.1 CLP-M\*\* (Atomic Absorption, Flame Technique)

Optimum Concentration Range: 1-20 mg/L using a wavelength of 276.8 nm

Sensitivity: 0.5 mg/L

Approximate Detection Limit: 0.1 mg/L

Preparation of Standard Solution

1. Stock Solution: Dissolve 1.303 g of thallium nitrate,  $TlNO_3$  (analytical reagent grade) in deionized distilled water. Add 10 mL of conc. nitric acid and dilute to 1 liter with deionized distilled water. 1 mL = 1 mg Tl (1000 mg/L).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. The calibration standards must be prepared using nitric acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrumental Parameters (General)

1. Thallium hollow cathode lamp
2. Wavelength: 276.8 nm
3. Fuel: Acetylene
4. Oxidant: Air
5. Type of flame: Oxidizing

Notes

1. For concentrations of thallium below 0.2 mg/L, use of the Furnace Technique (Method 279.2 CLP-M) is recommended.

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\*This method may only be used under specified conditions.

\*\*CLP-M Modified for the Contract Laboratory Program.

## VANADIUM\*

## Method 286.1 CLP-M\*\* (Atomic Absorption, Flame Technique)

Optimum Concentration Range: 2-100 mg/L using a wavelength of 318.4 nm

Sensitivity: 0.8 mg/L

Approximate Detection Limit: 0.2 mg/L

Preparation of Standard Solution

1. Stock Solution: Dissolve 1.7854 g of vanadium pentoxide,  $V_2O_5$  (analytical reagent grade) in 10 mL of conc. nitric acid and dilute to 1 liter with deionized distilled water. 1 mL = 1 mg V (1000 mg/L).
2. Aluminum nitrate solution: Dissolve 139 g aluminum nitrate,  $Al(NO_3)_3 \cdot 9H_2O$ , in 150 mL of deionized distilled water; heat to effect solution. Allow to cool and make up to 200 mL.
3. Prepare dilutions of the stock vanadium solution to be used as calibration standards at the time of analysis. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation. To each 100 mL of standard and sample alike, add 2 mL of the aluminum nitrate solution.

Instrumental Parameters (General)

1. Vanadium hollow cathode lamp
2. Wavelength: 318.4 nm
3. Fuel: Acetylene
4. Oxidant: Nitrous Oxide
5. Type of flame: Fuel rich

Interferences

1. It has been reported that high concentrations of aluminum and titanium increase the sensitivity of vanadium. This interference can be controlled by adding excess aluminum (1000 ppm) to both samples and standards. [Talanta 15, 871 (1968)].

Notes

1. For concentrations of vanadium below 0.5 mg/L, use of the Furnace Technique (Method 282.6 CLP-M) is recommended.

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\*This method may only be used under specified conditions.

\*\*CLP-M Modified for the Contract Laboratory Program.

## ZINC\*

## Method 289.1 CLP-M\*\* (Atomic Absorption, Flame Technique)

Optimum Concentration Range: 0.05-1 mg/L using a wavelength of 213.9 nm  
Sensitivity: 0.02 mg/L  
Approximate Detection Limit: 0.005 mg/L

Preparation of Standard Solution

1. Stock Solution: Carefully weigh 1.00 g of zinc metal (analytical reagent grade) and dissolve cautiously in 10 mL  $\text{HNO}_3$ . When solution is complete make up to 1 liter with deionized distilled water. 1 mL = 1 mg Zn (1000 mg/L).
2. Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. The calibration standards must be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after sample preparation.

Instrumental Parameters (General)

1. Zinc hollow cathode lamp
2. Wavelength: 213.9 nm
3. Fuel: Acetylene
4. Oxidant: Air
5. Type of flame: Oxidizing

Notes

1. High levels of silicon may interfere.
2. The air-acetylene flame absorbs about 25% of the energy at the 213.9 nm line.
3. The sensitivity may be increased by the use of low-temperature flames.
4. Some container cap liners can be a source of zinc contamination. To circumvent or avoid this problem, the use of the polypropylene caps is recommended.
5. For concentrations of zinc below 0.01 mg/L, use of the Furnace Technique (Method 289.2 CLP-M) is recommended.

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\*This method may only be used under specified conditions.

\*\*CLP-M Modified for the Contract Laboratory Program.





EXHIBIT E

QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS

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## SECTION I

### GENERAL QA/QC PRACTICES

Standard laboratory practices for laboratory cleanliness as applied to glassware and apparatus must be adhered to. Laboratory practices with regard to reagents, solvents, and gases must also be adhered to. For additional guidelines regarding these general laboratory procedures, see Sections 4 and 5 of the Handbook for Analytical Quality Control in Water and Wastewater Laboratories EPA-600/4-79-019, USEPA Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, September 1982.



## SECTION II

### SPECIFIC QA/QC PROCEDURES

The quality assurance/quality control (QA/QC) procedures defined herein must be used by the Contractor when performing the methods specified in Exhibit D. When additional QA/QC procedures are specified in the methods in Exhibit D, the Contractor must also follow these procedures. NOTE: The cost of performing all QA/QC procedures specified in this Statement of Work is included in the price of performing the bid lot, except for duplicate, spike, and laboratory control sample analyses, which shall be considered separate sample analyses.

The purpose of this document is to provide a uniform set of procedures for the analysis of inorganic constituents of samples, documentation of methods and their performance, and verification of the sample data generated. The program will also assist laboratory personnel in recalling and defending their actions under cross examination if required to present court testimony in enforcement case litigation.

The primary function of the QA/QC program is the definition of procedures for the evaluation and documentation of sampling and analytical methodologies and the reduction and reporting of data. The objective is to provide a uniform basis for sample collection and handling, instrument and methods maintenance, performance evaluation, and analytical data gathering and reporting. Although it is impossible to address all analytical situations in one document, the approach taken here is to define minimum requirements for all major steps relevant to any inorganic analysis. In many instances where methodologies are available, specific quality control procedures are incorporated into the method documentation (Exhibit D). Ideally, samples involved in enforcement actions are analyzed only after the methods have met the minimum performance and documentation requirements described in this document.

The Contractor is required to participate in the Laboratory Audit and Intercomparison Study Program run by EPA EMSL-Las Vegas. The Contractor can expect to analyze at least two samples per calendar quarter during the contract period.

The Contractor must perform and report to SMO and EMSL as specified in Exhibit B quarterly verification of instrument detection limits (IDL) by the method specified in Exhibit E, by type and model for each instrument used on this contract. All the IDLs must meet the CRDLs specified in Exhibit C. For ICP methods, the Contractor must also report, as specified in Exhibit B, linearity range verification, all interelement correction factors, wavelengths used, and integration times.

In this Exhibit, as well as other places within this Statement of Work, the term "analytical sample" is used in discussing the required frequency or placement of certain QA/QC measurements. The term "analytical sample" is defined in the glossary, Exhibit G. As the term is used, analytical sample includes all field samples, including Performance Evaluation samples, received from an external source, but it also includes all required QA/QC samples (matrix spikes, analytical/post-digestion spikes, duplicates,

serial dilutions, LCS, ICS, CRDL standards, preparation blanks and linear range analyses) except those directly related to instrument calibration or calibration verification (calibration standards, ICV/ICB, CCV/CCB). A "frequency of 10%" means once every 10 analytical samples. Note: Calibration verification samples (ICV/CCV) and calibration verification blanks (ICB/CCB) are not counted as analytical samples when determining 10% frequency.

In order for the QA/QC information to reflect the status of the samples analyzed, all samples and their QA/QC analysis must be analyzed under the same operating and procedural conditions.

If any QC measurement fails to meet contract criteria, the analytical measurement may not be repeated prior to taking the appropriate corrective action as specified in Exhibit E.

The Contractor must report all QC data in the exact format specified in Exhibits B and H.

Sensitivity, instrumental detection limits (IDL's), precision, linear dynamic range and interference effects must be established for each analyte on a particular instrument. All reported measurements must be within the instrumental linear ranges. The analyst must maintain quality control data confirming instrument performance and analytical results.

In addition, the Contractor shall establish a quality assurance program with the objective of providing sound analytical chemical measurements. This program shall incorporate the quality control procedures, any necessary corrective action, and all documentation required during data collection as well as the quality assessment measures performed by management to ensure acceptable data production.

As evidence of such a program, the Contractor shall prepare a written Quality Assurance Plan (QAP) (see Section III) which describes the procedures that are implemented to achieve the following:

- Maintain data integrity, validity, and useability.

- Ensure that analytical measurement systems are maintained in an acceptable state of stability and reproducibility.

- Detect problems through data assessment and establishes corrective action procedures which keep the analytical process reliable.

- Document all aspects of the measurement process in order to provide data which are technically sound and legally defensible.

## SECTION III

### QUALITY ASSURANCE PLAN

The QAP must present, in specific terms, the policies, organization, objectives, functional guidelines, and specific QA and QC activities designed to achieve the data quality requirements in this contract. Where applicable, SOPs pertaining to each element shall be included or referenced as part of the QAP. The QAP must be available during on-site laboratory evaluation and upon written request by the APO. The elements of the QAP are listed in the following outline.

#### A. Organization and Personnel

1. QA Policy and Objectives
2. QA Management
  - a. Organization
  - b. Assignment of QC and QA Responsibilities
  - c. Reporting Relationships
  - d. QA Document Control Procedures
  - e. QA Program Assessment Procedures
3. Personnel
  - a. Resumes
  - b. Education and Experience Pertinent to this Contract
  - c. Training Progress

#### B. Facilities and Equipment

1. Instrumentation and Backup Alternatives
2. Maintenance Activities and Schedules

#### C. Document Control

1. Laboratory Notebook Policy
2. Samples Tracking/Custody Procedures
3. Logbook Maintenance and Archiving Procedures
4. SDG File Organization, Preparation and Review Procedures

5. Procedures for Preparation, Approval, Review, Revision, and Distribution of SOPs
6. Process for Revision of Technical or Documentation Procedures

D. Analytical Methodology

1. Calibration Procedures and Frequency
2. Sample Preparation Procedures
3. Sample Analysis Procedures
4. Standards Preparation Procedures
5. Decision Processes, Procedures, and Responsibility for Initiation of Corrective Action

E. Data Generation

1. Data Collection Procedures
2. Data Reduction Procedures
3. Data Validation Procedures
4. Data Reporting and Authorization Procedures

F. Quality Assurance

1. Data Quality Assurance
2. Systems/Internal Audits
3. Performance/External Audits
4. Corrective Action Procedures
5. Quality Assurance Reporting Procedures
6. Responsibility Designation

G. Quality Control

1. Solvent, Reagent and Adsorbent Check Analysis
2. Reference Material Analysis
3. Internal Quality Control Checks
4. Corrective Action and Determination of QC Limit Procedures
5. Responsibility Designation



#### Updating and Submission of the QAP:

Within 60 Days of contract award:

During the contract solicitation process, the Contractor was required to submit their QAP to EMSL/LV and NEIC. Within sixty (60) days after contract award, the Contractor shall send a revised QAP, fully compliant with the requirements of this contract, to the Technical Project Officer, EMSL/LV and NEIC. The revised QAP will become the official QAP under the contract. The revised QAP must include:

- 1) Changes resulting from A) The Contractor's internal review of their organization, personnel, facility, equipment, policy and procedures and B) The Contractor's implementation of the requirements of the contract; and,
- 2) Changes resulting from the Agency's review of the laboratory evaluation sample data, bidder supplied documentation, and recommendations made during the pre-award On-Site laboratory evaluation

#### Subsequent submissions:

During the term of contract, the Contractor shall amend the QAP when the following circumstances occur:

- 1) The Agency modifies the contract,
- 2) The Agency notifies the Contractor of deficiencies in the QAP document
- 3) The Agency notifies the Contractor of deficiencies resulting from the Agency's review of the Contractor's performance,
- 4) The Contractor identifies deficiencies resulting from their internal review of their QAP document,
- 5) The Contractor's organization, personnel, facility, equipment, policy or procedures change,
- 6) The Contractor identifies deficiencies resulting from the internal review of their organization, personnel, facility, equipment, policy or procedures changes.

The Contractor shall amend the QAP within 30 days of when the circumstances listed above result in a discrepancy between what was previously described in the QAP and what is presently occurring at the Contractor's facility.

When the QAP is amended, all changes in the QAP must be clearly marked (e.g., a bar in the margin indicating where the change is found in the document, or highlighting the change by underlining the change, bold printing the change, or using a different print font). The amended section pages must have the date on which the changes were implemented. The Contractor shall incorporate all amendments to the current QAP document. The Contractor shall archive all amendments to the QAP document for future reference by the Agency.

The Contractor shall send a copy of the current QAF document within 14 days of a request by the Technical Project Officer or Administrative Project Officers to the designated recipients.

**Corrective Action:**

If a Contractor fails to adhere to the requirements listed in this section, a Contractor may expect, but the Agency is not limited to the following actions: reduction of numbers of samples sent under this contract, suspension of sample shipment to the Contractor, data package audit, an On-Site laboratory evaluation, remedial performance evaluation sample, and/or contract sanctions, such as a Cure Notice.

## SECTION IV

### STANDARD OPERATING PROCEDURES

In order to obtain reliable results, adherence to prescribed analytical methodology is imperative. In any operation that is performed on a repetitive basis, reproducibility is best accomplished through the use of Standard Operating Procedures (SOPs). As defined by the EPA, an SOP is a written document which provides directions for the step-by-step execution of an operation, analysis, or action which is commonly accepted as the method for performing certain routine or repetitive tasks.

SOPs prepared by the Contractor must be functional: i.e., clear, comprehensive, up-to-date, and sufficiently detailed to permit duplication of results by qualified analysts. All SOPs, as presented to the Agency, must reflect activities as they are currently performed in the laboratory. In addition, all SOPs must be:

- o Consistent with current EPA regulations, guidelines, and the CLP contract's requirements.
- o Consistent with instruments manufacturers's specific instruction manuals.
- o Available to the EPA during an On-Site Laboratory Evaluation. A complete set of SOPs shall be bound together and available for inspection at such evaluations. During On-Site Laboratory evaluations, laboratory personnel may be asked to demonstrate the application of the SOPs.
- o Capable of providing for the development of documentation that is sufficiently complete to record the performance of all tasks required by the protocol.
- o Capable of demonstrating the validity of data reported by the Contractor and explain the cause of missing or inconsistent results.
- o Capable of describing the corrective measures and feedback mechanism utilized when analytical results do not meet protocol requirements.
- o Reviewed regularly and updated as necessary when contract, facility, or Contractor procedural modifications are made.
- o Archived for future reference in usability or evidentiary situations.
- o Available at specific work stations as appropriate
- o Subject to a document control procedure which precludes the use of outdated or inappropriate SOPs.

#### SOP FORMAT:

The format for SOPs may vary depending upon the kind of activity for which they are prepared, however, at a minimum, the following sections must be included:

- o Title Page

- o Scope and Application
- o Definitions
- o Procedures
- o QC Limits
- o Corrective Action Procedures, Including Procedures for Secondary Review of Information Being Generated
- o Documentation Description and Example Forms
- o Miscellaneous Notes and Precautions
- o References

#### SOPS REQUIRED:

The following SOPs are required by the Agency:

1. Evidentiary SOP  
Evidentiary SOPs for required chain-of-custody and document control are discussed in Exhibit F
2. Sample Receipt and Storage
  - a. Sample receipt and identification logbooks
  - b. Refrigerator temperature logbooks
  - c. Security precautions
3. Sample preparation
4. Glassware cleaning
5. Calibration (Balances, etc.)
  - a. Procedures
  - b. Frequency requirements
  - c. Preventative maintenance schedule and procedures
  - d. Acceptance criteria and corrective actions
  - e. Logbook maintenance authorization
6. Analytical procedures (for each analytical system)
  - a. Instrument performance specifications
  - b. Instrument operating procedures
  - c. Data acquisition system operation
  - d. Procedures when automatic quantitation algorithms are overridden
  - e. QC required parameters
  - f. Analytical run/injection logbooks
  - g. Instrument error and editing flag descriptions and resulting corrective actions



7. Maintenance activities (for each analytical system)
  - a. Preventative maintenance schedule and procedures
  - b. Corrective maintenance determinants and procedures
  - c. Maintenance authorization
8. Analytical standards
  - a. Standard coding/identification and inventory system
  - b. Standards preparation logbook(s)
  - c. Standard preparation procedures
  - d. Procedures for equivalency/traceability analyses and documentation
  - e. Purity logbook (primary standards and solvents)
  - f. Storage, replacement, and labelling requirements
  - g. QC and corrective action measures
9. Data reduction procedures
  - a. Data processing systems operation
  - b. Outlier identification methods
  - c. Identification of data requiring corrective action
  - d. Procedures for format and/or forms for each operation
10. Documentation policy/procedures
  - a. Laboratory/analyst's notebook policy, including review policy
  - b. Complete SDG File contents
  - c. Complete SDG File organization and assembly procedures, including review policy
  - d. Document inventory procedures, including review policy
11. Data validation/self inspection procedures
  - a. Data flow and chain-of-command for data review
  - b. Procedures for measuring precision and accuracy
  - c. Evaluation parameters for identifying systematic errors
  - d. Procedures to assure that hardcopy and diskette deliverables are complete and compliant with the requirements in SOW Exhibits B and H.
  - e. Procedures to assure that hardcopy deliverables are in agreement with their comparable diskette deliverables.
  - f. Demonstration of internal QA inspection procedure (demonstrated by supervisory sign-off on personal notebooks, internal laboratory evaluation samples, etc.).
  - g. Frequency and type of internal audits (eg., random, quarterly, spot checks, perceived trouble areas).

- h. Demonstration of problem identification-corrective actions and resumption of analytical processing. Sequence resulting from internal audit (i.e., QA feedback).
  - i. Documentation of audit reports, (internal and external), response, corrective action, etc.
12. Data management and handling
- a. Procedures for controlling and estimating data entry errors.
  - b. Procedures for reviewing changes to data and deliverables and ensuring traceability of updates.
  - c. Lifecycle management procedures for testing, modifying and implementing changes to existing computing systems including hardware; software; and documentation or installing new systems.
  - d. Database security, backup and archival procedures including recovery from system failures.
  - e. System maintenance procedures and response time.
  - f. Individuals(s) responsible for system operation, maintenance, data integrity and security.
  - g. Specifications for staff training procedures.

#### SOPS DELIVERY REQUIREMENTS:

Updating and submission of SOPs:

Within 60 days of contract award:

During the contract solicitation process, the Contractor was required to submit their SOPs to EMSL/LV and NEIC. Within sixty (60) days after contract award, the Contractor shall send a complete revised set of SOPs, fully compliant with the requirements of this contract, to the Technical Project Officer, EMSL/LV and NEIC. The revised SOPs will become the official SOPs under the contract. The revised SOPs must include:

- 1) Changes resulting from A) the Contractor's internal review of their procedures and B) the Contractor's implementation of the requirements of the contract;
- 2) Changes resulting from the Agency's review of the laboratory evaluation sample data, bidder supplied documentation, and recommendations made during the pre-award On-Site laboratory evaluation.

Subsequent Submissions:

During the term of contract, the Contractor shall amend the SOPs when the following circumstances occur:

- 1) The Agency modifies the contract,
- 2) The Agency notifies the Contractor of deficiencies in their SOPs documentation

- 3) The Agency notifies the Contractor of deficiencies resulting from the Agency's review of the Contractor's performance,
- 4) The Contractor's procedures change,
- 5) The Contractor identifies deficiencies resulting from the internal review of their SOPs documentation, or
- 6) The Contractor identifies deficiencies resulting from the internal review of their procedures.

The SOPs must be amended or new SOPs must be written within 30 days of when the circumstances listed above result in a discrepancy between what was previously described in the SOPs and what is presently occurring at the Contractor's facility. All changes in the SOPs must be clearly marked (e.g., a bar in the margin indicating where the change is in the document, or highlighting the change by underlining the change, bold printing the change, or using a different print font). The amended/new SOPs must have the date on which the changes were implemented.

When the SOPs are amended or new SOPs are written, the Contractor shall document in a letter the reasons for the changes, and submit the amended SOPs or new SOPs to the Technical Project Officer, EMSL/LV (quality assurance/technical SOPs) and NEIC (evidentiary SOPs). The Contractor shall send the letter and the amended sections of the SOPs or new SOPs within 14 days of the change. An alternate delivery schedule for the submittal of the letter and amended/new SOPs may be proposed by the Contractor, but it is the sole decision of the Agency, represented either by the Technical Project Officer or Administrative Project Officer, to approve or disapprove the alternate delivery schedule. If an alternate delivery schedule is proposed, the Contractor shall describe in a letter to the Technical Project Officer, Administrative Project Officer, and the Contracting Officer why he/she is unable to meet the delivery schedule listed in this section. The Technical Project Officer/Administrative Project Officer will not grant an extension for greater than 30 days for amending/writing new SOPs. The Technical Project Officer/Administrative Project Officer will not grant an extension for greater than 14 days for submission of the letter documenting the reasons for the changes and for submitting amended/new SOPs. The Contractor shall proceed and not assume that an extension will be granted until so notified by the TPO and/or APO.

The Contractor shall send a complete set of current SOPs within 14 days of a request by the Technical Project Officer or Administrative Project Officer to the recipients he/she designates.

**Corrective action:**

If a Contractor fails to adhere to the requirements listed in this section, a Contractor may expect, but the Agency is not limited to the following action: reduction of number of samples sent under this contract, suspension of sample shipment to the Contractor, data package audit, On-Site laboratory evaluation, remedial performance evaluation sample, and/or contract sanction, such as a Cure Notice.

## SECTION V

### REQUIRED QA/QC OPERATIONS.

This section outlines the minimum QA/QC operations necessary to satisfy the analytical requirements of the contract. The following QA/QC operations must be performed as described in this Exhibit:

1. Instrument Calibration
2. Initial Calibration Verification (ICV) and Continuing Calibration Verification (CCV)
3. CRDL Standards for AA (CRA) and ICP (CRI)
4. Initial Calibration Blank (ICB), Continuing Calibration Blank (CCB), and Preparation Blank (PB) Analyses
5. ICP Interference Check Sample (ICS) Analyses
6. Spike Sample Analysis (S)
7. Duplicate Sample Analysis (D)
8. Laboratory Control Sample (LCS) Analysis
9. ICP Serial Dilution Analysis (L)
10. Instrument Detection Limit (IDL) Determination
11. Interelement Corrections for ICP (ICP)
12. Linear Range Analysis (LRA)
13. Furnace AA QC Analyses

#### 1. Instrument Calibration

Guidelines for instrumental calibration are given in EPA 600/4-79-020 and/or Exhibit D. Instruments must be calibrated daily or once every 24 hours and each time the instrument is set up. The instrument standardization date and time must be included in the raw data.

For atomic absorption systems, calibration standards are prepared by diluting the stock metal solutions at the time of analysis. Date and time of preparation and analysis must be given in the raw data.

Calibration standards must be prepared fresh daily or each time an analysis is to be made and discarded after use. For atomic absorption systems, prepare a blank and at least three calibration standards in graduated amounts in the appropriate range. One atomic absorption calibration standard must be at the CRDL. The calibration standards must be prepared using the same type of acid or combination of acids and at the same concentration as will result in the samples following sample preparation.

Beginning with the blank, aspirate or inject the standards and record the readings. If the AA instrument configuration prevents the required 4-point calibration, calibrate according to instrument manufacturer's recommendations, and analyze the remaining required standards immediately after calibration. Results for these standards must be



within 5% of the true value. Each standards concentration and the calculations to show that the 5% criterion has been met, must be given in the raw data. If the values do not fall within this range, recalibration is necessary.

The 5% criteria does not apply to the atomic absorption calibration standard at the CRDL.

Calibration standards for AA procedures must be prepared as described in Exhibit D.

Baseline correction is acceptable as long as it is performed after every sample or after the continuing calibration verification and blank check; resloping is acceptable as long as it is immediately preceded and immediately followed by compliant CCV and CCB. For cyanide and mercury, follow the calibration procedures outlined in Exhibit D. One cyanide calibration standard must be at the CRDL. For ICP systems, calibrate the instrument according to instrument manufacturer's recommended procedures. At least two standards must be used for ICP calibration. One of the standards must be a blank.

2. Initial Calibration Verification (ICV) and Continuing Calibration Verification (CCV)

a. Initial Calibration Verification (ICV)

Immediately after each of the ICP, AA and cyanide systems have been calibrated, the accuracy of the initial calibration shall be verified and documented for every analyte by the analysis of EPA Initial Calibration Verification Solution(s) at each wavelength used for analysis. When measurements exceed the control limits of Table 1-Initial and Continuing Calibration Verification Control Limits for Inorganic Analyses (in Exhibit E), the analysis must be terminated, the problem corrected, the instrument recalibrated, and the calibration reverified.

If the Initial Calibration Verification Solution(s) are not available from EPA, or where a certified solution of an analyte is not available from any source, analyses shall be conducted on an independent standard at a concentration other than that used for instrument calibration, but within the calibration range. An independent standard is defined as a standard composed of the analytes from a different source than those used in the standards for the instrument calibration.

For ICP, the Initial Calibration Verification Solution(s) must be run at each wavelength used for analysis. For CN, the initial calibration verification standard must be distilled. The Initial Calibration Verification for CN serves as a Laboratory Control Sample; thus it must be distilled with the batch of samples analyzed in association with that ICV. This means that an ICV must be distilled with each batch of samples analyzed and that the samples distilled with an ICV must be analyzed with that

particular ICV. The values for the initial and subsequent continuing calibration verification shall be recorded on FORM II-IN for ICP, AA, and cyanide analyses, as indicated.

b. Continuing Calibration Verification (CCV)

To ensure calibration accuracy during each analysis run, one of the following standards is to be used for continuing calibration verification and must be analyzed and reported for every wavelength used for the analysis of each analyte, at a frequency of 10% or every 2 hours during an analysis run, whichever is more frequent. The standard must also be analyzed and reported for every wavelength used for analysis at the beginning of the run and after the last analytical sample. The analyte concentrations in the continuing calibration standard must be one of the following solutions at or near the mid-range levels of the calibration curve:

1. EPA Solutions
2. NIST Standards
3. A Contractor-prepared standard solution

TABLE 1. INITIAL AND CONTINUING CALIBRATION VERIFICATION CONTROL LIMITS FOR INORGANIC ANALYSES

| Analytical Method | Inorganic Species | % of True Value (EPA Set) |            |
|-------------------|-------------------|---------------------------|------------|
|                   |                   | Low Limit                 | High Limit |
| ICP/AA            | Metals            | 90                        | 110        |
| Cold Vapor AA     | Mercury           | 80                        | 120        |
| Other             | Cyanide           | 85                        | 115        |

The same continuing calibration standard must be used throughout the analysis runs for a Case of samples received.

Each CCV analyzed must reflect the conditions of analysis of all associated analytical samples (the preceding 10 analytical samples or the preceding analytical samples up to the previous CCV). The duration of analysis, rinses and other related operations that may affect the CCV measured result may not be applied to the CCV to a greater extent than the extent applied to the associated analytical samples. For instance, the difference in time between a CCV analysis and the blank immediately following it as well as the difference in time between the CCV and the analytical sample immediately preceding it may not exceed the lowest difference in time between any two consecutive analytical samples associated with the CCV.

If the deviation of the continuing calibration verification is greater than the control limits specified in Table 1-Initial and Continuing Calibration Verification Control Limits for Inorganic Analyses, the analysis must be stopped, the problem corrected, the instrument must be recalibrated, the calibration verified and the reanalysis of preceding 10 analytical samples or all analytical samples analyzed since the last compliant calibration verification must be performed for the analytes affected. Information regarding the continuing verification of calibration shall be recorded on FORM II-IN for ICP, AA and cyanide as indicated.

3. CRDL Standards for ICP (CRI) and AA (CRA)

To verify linearity near the CRDL for ICP analysis, the Contractor must analyze an ICP standard (CRI) at two times the CRDL or two times the IDL, whichever is greater, at the beginning and end of each sample analysis run, or a minimum of twice per 8 hour working shift, whichever is more frequent, but not before Initial Calibration Verification. This standard must be run by ICP for every wavelength used for analysis, except those for Al, Ba, Ca, Fe, Mg, Na and K.

To verify linearity near the CRDL for AA analysis, the Contractor must analyze an AA standard (CRA) at the CRDL or the IDL, whichever is greater, at the beginning of each sample analysis run, but not before the Initial Calibration Verification.

Specific acceptance criteria for the two standards will be set by EPA in the future. In the interim, the Contractor must analyze and report these Standards on FORM II(PART 2)-IN.

4. Initial Calibration Blank (ICB), Continuing Calibration Blank (CCB), and Preparation Blank (PB) Analyses

a. Initial Calibration Blank (ICB) and Continuing Calibration Blank (CCB) Analyses

A calibration blank must be analyzed at each wavelength used for analysis immediately after every initial and continuing calibration verification, at a frequency of 10% or every 2 hours during the run, whichever is more frequent. The blank must be analyzed at the beginning of the run and after the last analytical sample. Note: A CCB must be run after the last CCV that was run after the last analytical sample of the run. The results for the calibration blanks shall be recorded on FORM III-IN for ICP, AA and cyanide analyses, as indicated. If the magnitude (absolute value) of the calibration blank result exceeds the IDL, the result must be so reported in ug/L on FORM III-IN, otherwise report as IDL-U. If the absolute value blank result exceeds the CRDL (Exhibit C), terminate analysis, correct the problem, recalibrate, verify the calibration and reanalyze the preceding 10 analytical samples or all analytical samples analyzed since the last compliant calibration blank.



b. Preparation Blank (PB) Analysis

At least one preparation blank (or reagent blank), consisting of deionized distilled water processed through each sample preparation and analysis procedure (See Exhibit D, Section III), must be prepared and analyzed with every Sample Delivery Group, or with each batch<sup>1</sup> of samples digested, whichever is more frequent.

The first batch of samples in an SDG is to be assigned to preparation blank one, the second batch of samples to preparation blank two, etc. (see FORM III-IN). Each data package must contain the results of all the preparation blank analyses associated with the samples in that SDG.

This blank is to be reported for each SDG and used in all analyses to ascertain whether sample concentrations reflect contamination in the following manner:

- 1) If the absolute value of the concentration of the blank is less than or equal to the Contract Required Detection Limit (Exhibit C), no correction of sample results is performed.
- 2) If any analyte concentration in the blank is above the CRDL, the lowest concentration of that analyte in the associated samples must be 10x the blank concentration. Otherwise, all samples associated with the blank with the analyte's concentration less than 10x the blank concentration and above the CRDL, must be redigested and reanalyzed for that analyte (except for an identified aqueous soil field blank). The sample concentration is not to be corrected for the blank value.
- 3) If the concentration of the blank is below the negative CRDL, then all samples reported below 10x CRDL associated with the blank must be redigested and reanalyzed.

The values for the preparation blank must be recorded in ug/L for aqueous samples and in mg/Kg for solid samples on FORM III-IN for ICP, AA, and cyanide analyses.

5. ICP Interference Check Sample (ICS) Analysis

To verify interelement and background correction factors, the Contractor must analyze and report the results for the ICP Interference Check Samples at the beginning and end of each analysis run or a minimum of twice per 8 hour working shift, whichever is more frequent, but not before Initial Calibration Verification. The ICP Interference Check Samples must be obtained from EPA (EMSL/LV) if available and analyzed according to the instructions supplied with the ICS.

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<sup>1</sup>A group of samples prepared at the same time.



The Interference Check Samples consist of two solutions: Solution A and Solution AB. Solution A consists of the interferents, and Solution AB consists of the analytes mixed with the interferents. An ICS analysis consists of analyzing both solutions consecutively (starting with Solution A) for all wavelengths used for each analyte reported by ICP.

Results for the ICP analyses of Solution AB during the analytical runs must fall within the control limit of  $\pm 20\%$  of the true value for the analytes included in the Interference Check Samples. If not, terminate the analysis, correct the problem, recalibrate the instrument, and reanalyze the analytical samples analyzed since the last good ICS. If true values for analytes contained in the ICS and analyzed by ICP are not supplied with the ICS, the mean must be determined by initially analyzing the ICS at least five times repetitively for the particular analytes. This mean determination must be made during an analytical run where the results for the previously supplied EPA ICS met all contract specifications. Additionally, the result of this initial mean determination is to be used as the true value for the lifetime of that solution (i.e., until the solution is exhausted).

If the ICP Interference Check Sample is not available from EPA, independent ICP Check Samples must be prepared with interferent and analyte concentrations at the levels specified in Table 2-Interferent and Analyte Elemental Concentrations Used for ICP Interference Check Sample. The mean value and standard deviation must be established by initially analyzing the Check Samples at least five times repetitively for each parameter on FORM IV-IN. Results must fall within the control limit of  $\pm 20\%$  of the established mean value. The mean and standard deviation must be reported in the raw data. Results from the Interference Check Sample analyses must be recorded on FORM IV-IN for all ICP parameters.

TABLE 2. INTERFERENT AND ANALYTE ELEMENTAL CONCENTRATIONS USED FOR ICP INTERFERENCE CHECK SAMPLE

| Analytes | (mg/L) | Interferents | (mg/L) |
|----------|--------|--------------|--------|
| Ag       | 1.0    | Al           | 500    |
| Ba       | 0.5    | Ca           | 500    |
| Be       | 0.5    | Fe           | 200    |
| Cd       | 1.0    | Mg           | 500    |
| Co       | 0.5    |              |        |
| Cr       | 0.5    |              |        |
| Cu       | 0.5    |              |        |
| Mn       | 0.5    |              |        |
| Ni       | 1.0    |              |        |
| Pb       | 1.0    |              |        |
| V        | 0.5    |              |        |
| Zn       | 1.0    |              |        |

6. Spike Sample Analysis (S)

The spike sample analysis is designed to provide information about the effect of the sample matrix on the digestion and measurement methodology. The spike is added before the digestion (i.e., prior to the addition of other reagents) and prior to any distillation steps (i.e., CN-). At least one spike sample analysis must be performed on each group of samples of a similar matrix type (i.e., water, soil) and concentration (i.e., low, medium) or for each Sample Delivery Group.<sup>2</sup>

If the spike analysis is performed on the same sample that is chosen for the duplicate sample analysis, spike calculations must be performed using the results of the sample designated as the "original sample" (see section 7, Duplicate Sample Analysis). The average of the duplicate results cannot be used for the purpose of determining percent recovery. Samples identified as field blanks cannot be used for spiked sample analysis. EPA may require that a specific sample be used for the spike sample analysis.

The analyte spike must be added in the amount given in Table 3-Spiking Levels for Spike Sample Analysis, for each element analyzed. Note: See Table 3 footnotes for concentration levels and applications. If two analytical methods are used to obtain the reported values for the same element within a Sample Delivery Group (i.e. ICP, GFAA), spike samples must be run by each method used.

If the spike recovery is not at or within the limits of 75-125%, the data of all samples received associated with that spike sample and determined by the same analytical method must be flagged with the letter "N" on FORMs I-IN and V-IN. An exception to this rule is granted in situations where the sample concentration exceeds the spike concentration by a factor of four or more. In such an event, the data shall be reported unflagged even if the percent recovery does not meet the 75-125% recovery criteria.

For flame AA, ICP, and CN analyses, when the pre-digestion/pre-distillation spike recovery falls outside the control limits and the sample result does not exceed 4x the spike added, a post-digestion/post-distillation spike must be performed for those elements that do not meet the specified criteria (exception: Ag). Spike the unspiked aliquot of the sample at 2x the indigenous level or 2x CRDL, whichever is greater. Results of the post-digestion/post-distillation spike must be reported on FORM V(PART 2)-IN. Note: No post digest spike is required for Hg.

In the instance where there is more than one spike sample per matrix and concentration per method per SDG, if one spike sample recovery is not within contract criteria, flag all the samples of the same matrix, level, and method in the SDG. Individual component percent recoveries (%R) are calculated as follows:

<sup>2</sup>EPA may require additional spike sample analysis, upon Administrative Project Officer request, for which the Contractor will be paid.

$$\% \text{Recovery} = \frac{(\text{SSR} - \text{SR})}{\text{SA}} \times 100$$

Where, SSR - Spiked Sample Result  
 SR - Sample Result  
 SA - Spike Added

When sample concentration is less than the instrument detection limit, use SR = 0 only for purposes of calculating % Recovery. The spike sample results, sample results and % Recovery (positive or negative) must be reported on FORM V-IN for ICP, AA and cyanide analyses, as indicated.

The units for reporting spike sample results will be identical to those used for reporting sample results in FORM I-IN (i.e., ug/L for aqueous and mg/Kg dry weight basis for solid).

TABLE 3. SPIKING LEVELS FOR SPIKE SAMPLE ANALYSIS

| Element   | For ICP/AA      |                                | For Furnace AA  |                                | Other <sup>(1)(2)</sup> |
|-----------|-----------------|--------------------------------|-----------------|--------------------------------|-------------------------|
|           | Water<br>(ug/L) | Soil <sup>(2)</sup><br>(mg/kg) | Water<br>(ug/L) | Soil <sup>(2)</sup><br>(mg/kg) |                         |
| Aluminum  | 2,000           | *                              |                 |                                |                         |
| Antimony  | 500             | 100                            | 100             | 20                             |                         |
| Arsenic   | 2,000           | 400                            | 40              | 8                              |                         |
| Barium    | 2,000           | 400                            |                 |                                |                         |
| Beryllium | 50              | 10                             |                 |                                |                         |
| Cadmium   | 50              | 10                             | 5               | 1                              |                         |
| Calcium   | *               | *                              |                 |                                |                         |
| Chromium  | 200             | 40                             |                 |                                |                         |
| Cobalt    | 500             | 100                            |                 |                                |                         |
| Copper    | 250             | 50                             |                 |                                |                         |
| Iron      | 1,000           | *                              |                 |                                |                         |
| Lead      | 500             | 100                            | 20              | 4                              |                         |
| Magnesium | *               | *                              |                 |                                |                         |
| Manganese | 500             | 100                            |                 |                                |                         |
| Mercury   |                 |                                |                 |                                | 1                       |
| Nickel    | 500             | 100                            |                 |                                |                         |
| Potassium | *               | *                              |                 |                                |                         |
| Selenium  | 2,000           | 400                            | 10              | 2                              |                         |
| Silver    | 50              | 10                             |                 |                                |                         |
| Sodium    | *               | *                              |                 |                                |                         |
| Thallium  | 2,000           | 400                            | 50              | 10                             |                         |
| Vanadium  | 500             | 100                            |                 |                                |                         |
| Zinc      | 500             | 100                            |                 |                                |                         |
| Cyanide   |                 |                                |                 |                                | 100 <sup>(3)</sup>      |

\*No spike required. NOTE: Elements without spike levels and not designated with an asterisk, must be spiked at appropriate levels.

<sup>1</sup>Spiking level reported is for both water and soil/sediment matrices.

<sup>2</sup>The levels shown indicate concentrations in the final digestate of the spiked sample (100 mL for mercury and 200 mL for all other metals) when the wet weight of 1 gram (for ICP, Furnace, and Flame AA), or 0.2 grams



(for mercury) of sample is taken for analysis. Adjustment must be made to maintain these spiking levels when the weight of sample taken deviates by more than 10% of these values. Appropriate adjustment must be made for microwave digestion procedure where 0.5 grams of sample or 50.0 mL (45.0 mL of sample plus 5.0 mL of acid) of aqueous sample are required for analysis.

<sup>3</sup>The level shown indicates the amount of cyanide that must be added to the original (undistilled) sample. For instance, 100 ug must be added per each Liter of aqueous sample. If the sample volume is 500 mL, then 50 ug of cyanide must be added. If the volume is 50 mL, then 5 ug of cyanide must be added.

For soil samples, 25 ug of cyanide must be added per each gram of solid sample taken for analysis. The spiking level is dependent on the weight of the sample taken and the final distillate volume. If one gram of sample is taken for analysis, and the final distillate volume is 250 mL, then the distillate must contain cyanide at a concentration of 100 ug/L. If five grams of sample are taken, then the distillate must contain cyanide at a concentration of 500 ug/L. Assuming a sample of one gram, the manual and semi-automated colorimetric methods call for a cyanide concentration of 25 ug per the 500 mL mixture of the sample, reagents, and water before distillation. The final distillate, in this case, contains cyanide at a concentration of 100 ug/L. For the midi-distillation method, a cyanide concentration of 25 ug must be added into the 50 mL mixture of sample, reagents, and water before distillation. This yields a cyanide concentration of 500 ug/L in the final distillate of 50 mL.

#### Duplicate Sample Analysis (D)

One duplicate sample must be analyzed from each group of samples of a similar matrix type (i.e., water, soil) and concentration (i.e., low, medium) or for each Sample Delivery Group.<sup>3</sup> Duplicates cannot be averaged for reporting on FORM I-IN.

Duplicate sample analyses are required for percent solids. Samples identified as field blanks cannot be used for duplicate sample analysis. EPA may require that a specific sample be used for duplicate sample analysis. If two analytical methods are used to obtain the reported values for the same element for a Sample Delivery Group (i.e., ICP, GFAA), duplicate samples must be run by each method used.

The relative percent differences (RPD) for each component are calculated as follows:

$$RPD = \frac{|S - D|}{(S+D)/2} \times 100$$

Where, RPD - Relative Percent Difference  
S - First Sample Value (original)  
D - Second Sample Value (duplicate)

<sup>3</sup>EPA may require additional duplicate sample analyses, upon Administrative Project Officer request, for which the Contractor will be paid.



The results of the duplicate sample analyses must be reported on FORM VI-IN in ug/L for aqueous samples and mg/Kg dry weight basis for solid original and duplicate samples. A control limit of 20% for RPD shall be used for original and duplicate sample values greater than or equal to 5x CRDL (Exhibit C). A control limit of ( $\pm$ ) the CRDL must be used if either the sample or duplicate value is less than 5x CRDL, and the absolute value of the control limit (CRDL) must be entered in the "Control Limit" column on FORM VI-IN.

If one result is above the 5x CRDL level and the other is below, use the  $\pm$  CRDL criteria. If both sample values are less than the IDL, the RPD is not calculated on FORM VI-IN. For solid sample or duplicate results < 5x CRDL, enter the absolute value of the CRDL, corrected for sample weight and percent solids, in the "Control Limit" column. If the duplicate sample results are outside the control limits, flag all the data for samples received associated with that duplicate sample with an "\*" on FORMs I-IN and VI-IN. In the instance where there is more than one duplicate sample per SDG, if one duplicate result is not within contract criteria, flag all samples of the same matrix, concentration, and method in the SDG. The percent difference data will be used by EPA to evaluate the long-term precision of the methods for each parameter. Specific control limits for each element will be added to FORM VI-IN at a later date based on these precision results.

#### 8. Laboratory Control Sample (LCS) Analysis

Aqueous and solid Laboratory Control Samples (LCS) must be analyzed for each analyte using the same sample preparations, analytical methods and QA/QC procedures employed for the EPA samples received. The aqueous LCS solution must be obtained from EPA (if unavailable, the Initial Calibration Verification Solutions may be used). One aqueous LCS must be prepared and analyzed for every group of aqueous samples in a Sample Delivery Group, or for each batch of aqueous samples digested, whichever is more frequent. An aqueous LCS is not required for mercury and cyanide analysis.

The EPA-provided solid LCS must be prepared and analyzed using each of the procedures applied to the solid samples received (exception: percent solids determination not required). If the EPA solid LCS is unavailable, other EPA Quality Assurance Check samples or other certified materials may be used. One solid LCS must be prepared and analyzed for every group of solid samples in a Sample Delivery Group, or for each batch of samples digested, whichever is more frequent.

All LCS results and percent recovery (%R) will be reported on FORM VII-IN. If the percent recovery for the aqueous LCS falls outside the control limits of 80-120% (exception: Ag and Sb), the analyses must be terminated, the problem corrected, and the samples associated with that LCS redigested and reanalyzed.

If the results for the solid LCS fall outside the control limits established by EPA, the analyses must be terminated, the problem corrected, and the samples associated with that LCS redigested and reanalyzed.

9. ICP Serial Dilution Analysis (L)

Prior to reporting concentration data for the analyte elements, the Contractor must analyze and report the results of the ICP Serial Dilution Analysis. The ICP Serial Dilution Analysis must be performed on a sample from each group of samples of a similar matrix type (i.e., water, soil) and concentration (i.e., low, medium) or for each Sample Delivery Group, whichever is more frequent. Samples identified as field blanks cannot be used for Serial Dilution Analysis.

If the analyte concentration is sufficiently high (minimally a factor of 50 above the instrumental detection limit in the original sample), the serial dilution (a five fold dilution) must then agree within 10% of the original determination after correction for dilution. If the dilution analysis for one or more analytes is not at or within 10%, a chemical or physical interference effect must be suspected, and the data for all affected analytes in the samples received associated with that serial dilution must be flagged with an "E" on FORM IX-IN and FORM I-IN.

The percent differences for each component are calculated as follows:

$$\% \text{ Difference} = \frac{|I - S|}{I} \times 100$$

where, I - Initial Sample Result

S - Serial Dilution Result (Instrument Reading x 5)

In the instance where there is more than one serial dilution per SDG, if one serial dilution result is not within contract criteria, flag all the samples of the same matrix and concentration in the Sample Delivery Group. Serial dilution results and "E" flags must be reported on FORM IX-IN.

10. Instrument Detection Limit (IDL) Determination

Before any field samples are analyzed under this contract, the instrument detection limits (in ug/L) must be determined for each instrument used, within 30 days of the start of contract analyses and at least quarterly (every 3 calendar months), and must meet the levels specified in Exhibit C.

The Instrument Detection Limits (in ug/L) shall be determined by multiplying by 3, the average of the standard deviations obtained on three nonconsecutive days from the analysis of a standard solution (each analyte in reagent water) at a concentration 3x-5x the instrument manufacturer's suggested IDL, with seven consecutive measurements per day. Each measurement must be performed as though it were a separate analytical sample (i.e., each measurement must be followed by a rinse and/or any other procedure normally performed between the analysis of separate samples). IDL's must be determined and reported for each wavelength used in the analysis of the samples.

The quarterly determined IDL for an instrument must always be used as the IDL for that instrument during that quarter. If the instrument is adjusted in anyway that may affect the IDL, the IDL for that instrument must be redetermined and the results submitted for use as the established IDL for that instrument for the remainder of the quarter.

IDLs must be reported for each instrument used on FORM X-IN submitted with each data package. If multiple AA instruments are used for the analysis of an element within a Sample Delivery Group, the highest IDL for the AAs must be used for reporting concentration values for that Sample Delivery Group. The same reporting procedure must be used for multiple ICPs.

11. Interelement Corrections for ICP

Before any field samples are analyzed under this contract, the ICP interelement correction factors must be determined prior to the start of contract analyses and at least annually thereafter. Correction factors for spectral interference due to Al, Ca, Fe, and Mg must be determined for all ICP instruments at all wavelengths used for each analyte reported by ICP. Correction factors for spectral interference due to analytes other than Al, Ca, Fe, and Mg must be reported if they were applied.

If the instrument was adjusted in anyway that may affect the ICP interelement correction factors, the factors must be redetermined and the results submitted for use. Results from interelement correction factors determination must be reported on FORM XI(PART 1)-IN and FORM XI(PART 2)-IN for all ICP parameters.

12. Linear Range Analysis (LRA)

For all ICP analyses, a linear range verification check standard must be analyzed and reported quarterly (every 3 calendar months) for each element on FORM XII-IN. The standard must be analyzed during a routine analytical run performed under this contract. The analytically determined concentration of this standard must be within 5% of the true value. This concentration is the upper limit of the ICP linear range beyond which results cannot be reported under this contract without dilution of the analytical sample.

13. Furnace Atomic Absorption (AA) QC Analyses

Because of the nature of the Furnace AA technique, the special procedures summarized in Figure 1-Furnace AA Analysis Scheme ("MSA Tree") will be required for quantitation. (These procedures do not replace those in Exhibit D of this SOW, but supplement the guidance provided therein.)

- a. All furnace analyses must fall within the calibration range. In addition, all analyses, except during full methods of standard addition (MSA), will require duplicate injections. The absorbance or concentration of each injection must be reported in the raw data as well as the average absorbance or concentration values and the relative standard deviation (RSD) or coefficient of variation



(CV). Average concentration values are used for reporting purposes. The Contractor must be consistent per method and SDG in choosing absorbance or concentration to evaluate which route is to be followed in the MSA Tree. The Contractor must also indicate which of the two is being used if both absorbance and concentration are reported in the raw data. For MSA analysis, the absorbance of each injection must be included in the raw data. A maximum of 10 full sample analyses to a maximum 20 injections may be performed between each consecutive calibration verifications and blanks. For concentrations greater than CRDL, the duplicate injection readings must agree within 20% RSD or CV, or the analytical sample must be rerun once (i.e., two additional burns). If the readings are still out, flag the value reported on FORM I-IN with an "M". The "M" flag is required for the analytical spike as well as the sample. If the analytical spike for a sample requires an "M" flag, the flag must be reported on FORM I-IN for that sample.

- b. All furnace analyses for each analytical sample, including those requiring an "M" flag, will require at least an analytical spike to determine if the MSA will be required for quantitation. The analytical spike<sup>4</sup> will be required to be at a concentration (in the sample) 2x CRDL (except for lead which must be at 20 ug/L). This requirement for an analytical spike will include the LCS and the preparation blank. (The LCS must be quantitated from the calibration curve and corrective action, if needed, taken accordingly. MSA is not to be performed on the LCS or preparation blank, regardless of spike recovery results.) If the preparation blank analytical spike recovery is out of control (85-115%), the spiking solution must be verified by respiking and rerunning the preparation blank once. If the preparation blank analytical spike recovery is still out of control, correct the problem and reanalyze all analytical samples associated with that blank. An analytical spike is not required on the pre-digestion spike sample.

The analytical spike of a sample must be run immediately after that sample. The percent recovery (%R) of the spike, calculated by the same formula as Spike Sample Analyses (see item 6, this section), will then determine how the sample will be quantitated, as follows:

- 1) If the spike recovery is less than 40%, the sample must be diluted and rerun with another spike. Dilute the sample by a factor of 5 to 10 and rerun. This step must only be performed once. If after the dilution the spike recovery is still <40%, report data and flag with an "E" to indicate interference problems.

<sup>4</sup>Analytical Spikes are post-digestion spikes to be prepared prior to analysis by adding a known quantity of the analyte to an aliquot of the digested sample. The unspiked sample aliquot must be compensated for any volume change in the spike samples by addition of deionized water to the unspiked sample aliquot. The volume of the spiking solution added must not exceed 10% of the analytical sample volume; this requirement also applies to MSA spikes.



- 2) If the spike recovery is greater than or equal to 40% and the sample absorbance or concentration is less than 50% of the "spike"<sup>5</sup>, report the sample results to the IDL. If the spike recovery is less than 85% or greater than 115%, flag the result with a "W".
  - 3) If the sample absorbance or concentration is greater than or equal to 50% of the spike and the spike recovery is at or between 85% and 115%, the sample must be quantitated directly from the calibration curve and reported down to the IDL.
  - 4) If the sample absorbance or concentration is greater than or equal to 50% of the spike and the spike recovery is less than 85% or greater than 115%, the sample must be quantitated by MSA.
- c. The following procedures will be incorporated into MSA analyses.
- 1) Data from MSA calculations must be within the linear range as determined by the calibration curve generated at the beginning of the analytical run.
  - 2) The sample and three spikes must be analyzed consecutively for MSA quantitation (the "initial" spike run data is specifically excluded from use in the MSA quantitation). Only single injections are required for MSA quantitation.  
  
Each full MSA counts as two analytical samples towards determining 10% QC frequency (i.e., five full MSAs can be performed between calibration verifications).
  - 3) For analytical runs containing only MSAs, single injections can be used for QC samples during that run. For instruments that operate in an MSA mode only, MSA can be used to determine QC samples during that run.
  - 4) Spikes must be prepared such that:
    - a) Spike 1 is approximately 50% of the sample concentration.
    - b) Spike 2 is approximately 100% of the sample concentration.
    - c) Spike 3 is approximately 150% of the sample concentration.
  - 5) The data for each MSA analysis must be clearly identified in the raw data documentation (using added concentration as the x-variable and absorbance as the y-variable) along with the slope, x-intercept, y-intercept and correlation coefficient (r) for the least squares fit of the data. The results must be reported on FORM VIII-IN. Reported values obtained by MSA

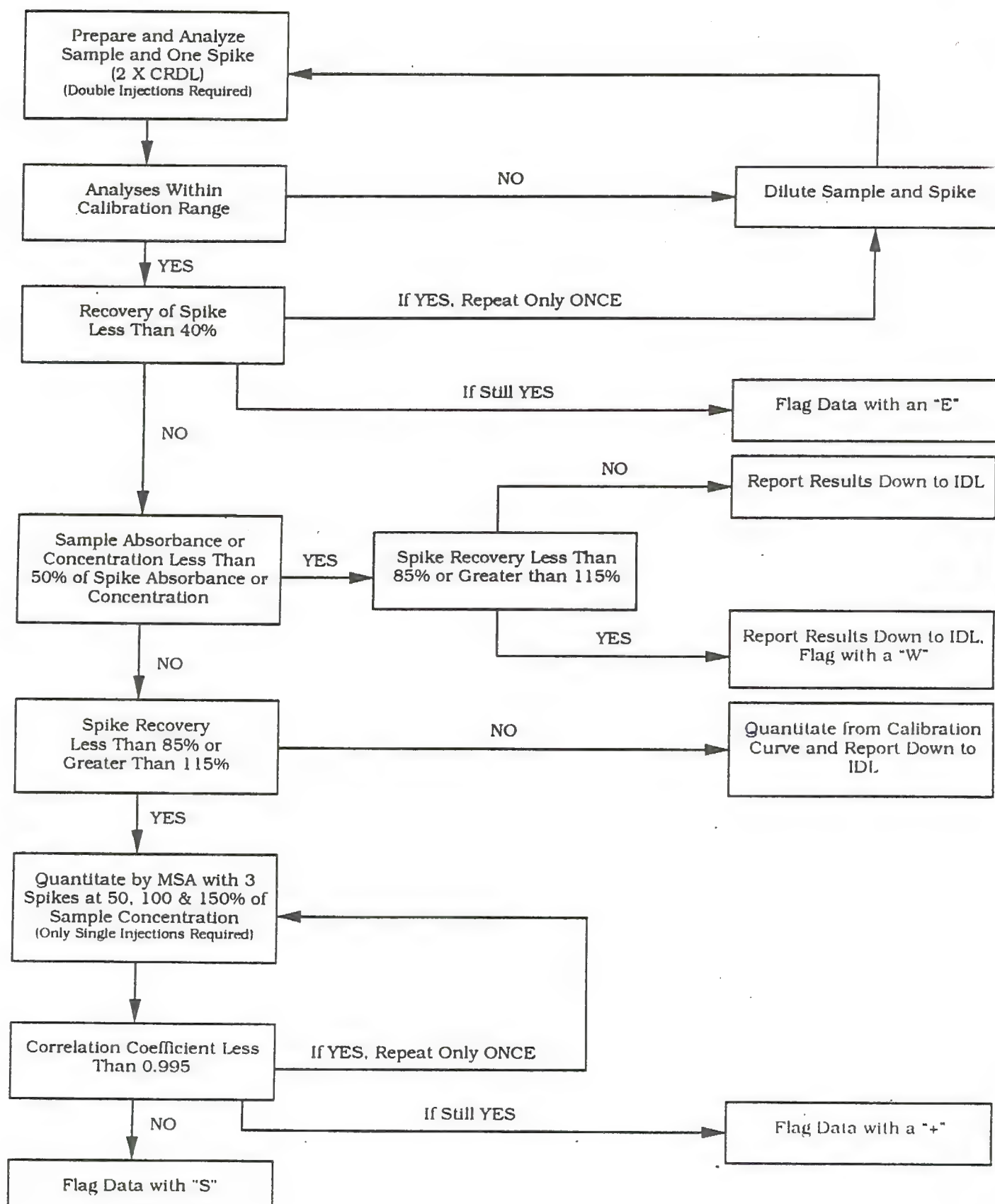
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<sup>5</sup>"Spike" is defined as [absorbance or concentration of spike sample] minus [absorbance or concentration of the sample].

must be flagged on the data sheet (FORM I-IN) with the letter "S" if the correlation coefficient is greater than or equal to 0.995.

- 6) If the correlation coefficient ( $r$ ) for a particular analysis is less than 0.995, the MSA analysis must be repeated once. If the correlation coefficient is still less than 0.995, report the results on FORM I-IN from the run with the best " $r$ " and flag the result with a "+" on FORM VIII-IN and FORM I-IN.

**Figure 1.**  
**Furnace Atomic Absorption Analysis Scheme**



## SECTION VI

### CONTRACT COMPLIANCE SCREENING

Contract Compliance Screening (CCS) is one aspect of the Government's contractual right of inspection of analytical data. CCS examines the Contractor's adherence to the contract requirements based on the sample data package delivered to the Agency.

CCS is performed by the Sample Management Office (SMO) under the direction of the EPA. To assure a uniform review, a set of standardized procedures have been developed to evaluate the sample data package submitted by a Contractor against the technical and completeness requirements of the contract.

CCS results are mailed to the Contractor and all other data recipients. The Contractor has a period of time to correct deficiencies. The Contractor must send all corrections to the Regional Client, EMSL/LV, and SMO.

CCS results are used in conjunction with other information to measure overall Contractor performance and to take appropriate actions to correct deficiencies in performance.

The Agency may generate a CCS trend report which summarizes CCS results over a given period of time. The Agency may send the CCS trend report or discuss the CCS trend report during an On-Site laboratory evaluation. In a detailed letter to the Technical Project Officer and Administrative Project Officer, the Contractor shall address the deficiencies and the subsequent corrective action implemented by the Contractor to correct the deficiencies within 14 days of receipt of the report or the On-Site laboratory evaluation. An alternate delivery schedule may be proposed by the Contractor, but it is the sole decision of the Agency, represented by the Technical Project Officer or Administrative Project Officer to approve or disprove the alternate delivery schedule. If an alternate delivery schedule is proposed, the Contractor shall describe in a letter to the Technical Project Officer, Administrative Project Officer, and Contracting Officer why he/she is unable to meet the delivery schedule listed in this section. The Technical Project Officer will not grant an extension for greater than 14 days for the Contractor's response to the CCS trend report.

If new SOPs are required to be written or SOPs are required to be amended because of the deficiencies and the subsequent corrective action implemented by the Contractor, the Contractor shall write/amend and submit the SOPs per the requirements listed in Exhibit E, Section IV.

If the Contractor fails to adhere to the requirements listed in this section, the Contractor may expect, but the Agency is not limited to the following actions: reduction of number of samples sent under the contract, suspension of sample shipment to the Contractor, data package audit, an On-Site laboratory evaluation, a remedial performance evaluation sample, and/or contract sanctions, such as a Cure Notice.



## SECTION VII

### ANALYTICAL STANDARD REQUIREMENTS

The U.S. Environmental Protection Agency may be unable to supply analytical reference standards either for direct analytical measurements or for the purpose of traceability. In these cases, all contract laboratories will be required to prepare from materials or purchase from private chemical supply houses those standards necessary to successfully and accurately perform the analyses required in this protocol.

#### A. Preparation of Chemical Standards from the Neat High Purity Bulk Material

If the laboratory cannot obtain analytical reference data from the USEPA, the laboratory may prepare their own chemical standards. Laboratories should obtain the highest purity possible when purchasing chemical standards; standards purchased at less than 97% purity must be documented as to why a higher purity could not be obtained.

1. If required by the manufacturer, the chemical standards must be kept refrigerated when not being used in the preparation of standard solutions. Proper storage of chemicals is essential in order to safeguard them from decomposition.
2. The purity of a compound can sometimes be misrepresented by a chemical supply house. Since knowledge of purity is needed to calculate the concentration of solute in a solution standard, it is the contract laboratory's responsibility to have analytical documentation ascertaining that the purity of each compound is correctly stated. Purity confirmation, when performed, should use appropriate techniques. Use of two or more independent methods is recommended. The correction factor for impurity when weighing neat materials in the preparation of solution standards is:

Equation 1

$$\text{weight of impure compound} = \frac{\text{weight of pure compound}}{(\text{percent purity}/100)}$$

where "weight of pure compound" is that required to prepare a specific volume of a solution standard of a specified concentration.

3. Mis-identification of compounds occasionally occurs and it is possible that a mislabeled compound may be received from a chemical supply house. It is the contract laboratory's responsibility to have analytical documentation ascertaining that all compounds used in the preparation of solution standards be correctly identified.
4. Log notebooks are to be kept for all weighing and dilutions. All subsequent dilutions from the primary standard and the calculations for determining their concentrations are to be recorded and verified by a second person. All solution standards

are to be refrigerated, if required, when not in use. All solution standards are to be clearly labeled as to the identity of the analyte or analytes, concentration, date prepared, solvent, and initials of the preparer.

B. Purchase of chemical standards already in solution

1. Solutions of analytical reference standards can be purchased by Contractors provided they meet the following criteria:

Laboratories must maintain documentation of the purity confirmation of the material to verify the integrity of the standard solutions they purchase.

2. The Contractor must purchase standards for which the quality is demonstrated statistically and analytically by a method of the supplier's choice. One way this can be demonstrated is to prepare and analyze three solutions; a high standard, a low standard, and a standard at the target concentration (see parts a and b below). The supplier must then demonstrate that the analytical results for the high standard and low standard are consistent with the difference in theoretical concentrations. This is done by the Student's t-test in part "d". If this is achieved, the supplier must then demonstrate that the concentration of the target standard lies midway between the concentrations of the low and high standards. This is done by the Student's t-test in part e. Thus the standard is certified to be within 10 percent of the target concentration.

If the procedure above is used, the supplier must document that the following have been achieved:

- a. Two solutions of identical concentration must be prepared independently from neat materials. An aliquot of the first solution must be diluted to the intended concentration (the "target standard"). One aliquot is taken from the second solution and diluted to a concentration ten percent greater than the target standard. This is called the "high standard". One further aliquot is taken from the second solution and diluted to a concentration 10 percent less than the target standard. This is called the "low standard".
- b. Six replicate analyses of each standard (a total of 18 analyses) must be performed in the following sequence: low standard, target, high standard, low standard, target standard, high standard, ...
- c. The mean and variance of the six results for each solution must be calculated.

Equation 2

$$\text{MEAN} = (Y_1 + Y_2 + Y_3 + Y_4 + Y_5 + Y_6) / 6$$

## Equation 3

$$\text{VARIANCE} = (Y_1^2 + Y_2^2 + Y_3^2 + Y_4^2 + Y_5^2 + Y_6^2 - (6 \cdot \text{MEAN})^2) / 5$$

The values  $Y_1, Y_2, Y_3, \dots$ , represent the results of the six analyses of each standard. The means of the low, target, and high standards are designated  $M_1, M_2$ , and  $M_3$ , respectively. The variances of the low, target, and high standards are designated  $V_1, V_2$ , and  $V_3$ , respectively. Additionally, a pooled variance,  $V_p$ , is calculated.

## Equation 4

$$V_p = (V_1 / (0.81) + V_2 + V_3 / (1.21)) / 3$$

If the square root of  $V_p$  is less than one percent of  $M_2$ , then  $M_2^2 / 10,000$  is to be used as the value of  $V_p$  in all subsequent calculations.

- d. The test statistic must be calculated:

## Equation 5

$$\text{TEST STATISTIC} = |(M_3 / 1.1) - (M_1 / 0.9)| / (V_p / 3)^{0.5}$$

If the test statistic exceeds 2.13 then the supplier has failed to demonstrate a twenty percent difference between the high and low standards. In such a case, the standards are not acceptable.

- e. The test statistic must be calculated:

## Equation 6

$$\text{TEST STATISTIC} = |M_2 - (M_1 / 1.8) - (M_3 / 2.2)| / (V_p / 4)^{0.5}$$

If the test statistic exceeds 2.13, the supplier has failed to demonstrate that the target standard concentration is midway between the high and low standards. In such a case, the standards are not acceptable.

- f. The 95 percent confidence intervals for the mean result of each standard must be calculated:

## Equation 7

$$\text{Interval for Low Standard} = M_1 \pm (2.13)(V_p / 6)^{0.5}$$

## Equation 8

$$\text{Interval for Target Standard} = M_2 \pm (2.13)(V_p / 6)^{0.5}$$

## Equation 9

$$\text{Interval for High Standard} = M_3 \pm (2.13)(V_p / 6)^{0.5}$$

These intervals must not overlap. If overlap is observed, then the supplier has failed to demonstrate the ability to discriminate the 10 percent difference in concentrations. In such a case, the standards are not acceptable.



In any event, the laboratory is responsible for the quality of the standards employed for analyses under this contract.

C. Requesting Standards From the EPA Standards Repository

Solutions of analytical reference materials can be ordered from the U.S. EPA Chemical Standards Repository, depending on availability. The Contractor can place an order for standards only after demonstrating that these standards are not available from commercial vendors either in solution or as a neat material.

D. Documentation of the Verification and Preparation of Chemical Standards

It is the responsibility of each laboratory to maintain the necessary documentation to show that the chemical standards they have used in the performance of CLP analysis conform to the requirements previously listed. Weighing logbooks, calculations, raw data, etc., whether produced by the laboratory or purchased from chemical supply houses, must be maintained by the laboratory and may be subject to review during On-Site inspection visits. In those cases where the documentation is supportive of the analytical results of data packages sent to EPA, such documentation is to be kept on file by the laboratories for a period of one year.

Upon request by the Technical Project Officer or Administrative Project Officer, the Contractor shall submit their most recent previous year's documentation (12 months) for the verification and preparation of chemical standards within 14 days of the receipt of request to the recipients he/she designates.

The Agency may generate a report discussing deficiencies in the Contractor's documentation for the verification and preparation of chemical standards or may discuss the deficiencies during an On-Site laboratory evaluation. In a detailed letter to the Technical Project Officer, Administrative Project Officer, and EMSL-LV, the Contractor shall address the deficiencies and the subsequent corrective action implemented by the Contractor to correct the deficiencies within 14 days of receipt of the report or the On-Site laboratory evaluation. An alternate delivery schedule may be proposed by the Contractor, but it is the sole decision of the Agency, represented either by the Technical Project Officer or Administrative Project Officer, to approve or disapprove the alternate delivery schedule. If an alternate delivery schedule is proposed, the Contractor shall describe in a letter to the Technical Project Officer, Administrative Project Officer, and the Contracting Officer why he/she is unable to meet the delivery schedule listed in this section. The Technical Project Officer/Administrative Project Officer will not grant an extension for greater than 14 days for the Contractor's response letter to the standards documentation report. The Contractor shall proceed and not assume that an extension will be granted until so notified by the TPO and/or APO.



If new SOPs are required to be written or SOPs are required to be amended because of the deficiencies and the subsequent corrective action implemented by the Contractor, the Contractor shall write/amend and submit the SOPs per the requirements listed in Exhibit E, Section IV.

If the Contractor fails to adhere to the requirements listed in Section VII, a Contractor may expect, but the Agency is not limited to the following actions: reduction of number of samples sent under the contract, suspension of sample shipment to Contractor, data package audit, an On-Site laboratory evaluation, a remedial laboratory evaluation sample, and/or contract sanctions, such as a Cure Notice.

## SECTION VIII

### DATA PACKAGE AUDITS

Data package audits are performed by the Agency for program overview and specific Regional concerns. Standardized procedures have been established to assure uniformity of the auditing process. Data packages are periodically selected from recently received cases. They are evaluated for the technical quality of hardcopy raw data, quality assurance, and the adherence to contractual requirements. This function provides external monitoring of program QC requirements.

Data package audits are used to assess the technical quality of the data and evaluate overall laboratory performance. Audits provide the Agency with an in-depth inspection and evaluation of the Case data package with regard to achieving QA/QC acceptability. A thorough review of the raw data is completed including: all instrument readouts used for the sample results, chromatograms and other documentation for deviations from the contractual requirements, a check for transcription and calculation errors, a review of the qualifications of the laboratory personnel involved with the Case, and a review of all current SOPs on file.

#### Responding to the data package audit report:

After completion of the data package audit, the Agency may send a copy of the data package audit report to the Contractor or may discuss the data package audit report on an On-Site laboratory evaluation. In a detailed letter to the Technical Project Officer, Administrative Project Officer, and EMSL/LV, the Contractor shall discuss the corrective actions implemented to resolve the deficiencies listed in the data package audit report within 14 days of receipt of the report. An alternate delivery schedule may be proposed by the Contractor, but it is the sole decision of the Agency, represented either by the Technical Project Officer or Administrative Project Officer, to approve or disapprove the alternate delivery schedule. If an alternate delivery schedule is proposed, the Contractor shall describe in a letter to the Technical Project Officer, Administrative Project Officer, and the Contracting Officer, why he/she is unable to meet the delivery schedule listed in this section. The Technical Project Officer/Administrative Project Officer will not grant an extension for greater than 14 days for the Contractor's response letter to the data package report. The Contractor shall proceed and not assume that an extension will be granted until so notified by the TPO and/or APO.

If new SOPs are required to be written or SOPs are required to be amended because of the deficiencies and the subsequent corrective action implemented by the Contractor, the Contractor shall write/amend and submit the SOPs per the requirements listed in Exhibit E, Section IV.

### Corrective Actions

If the Contractor fails to adhere to the requirements listed in this section, the Contractor may expect, but the Agency is not limited to the following actions: reduction in the numbers of samples sent under the contract, suspension of sample shipment to the Contractor, an On-Site laboratory evaluation, data package audit, remedial performance evaluation sample, and/or contract sanctions, such as a Cure Notice.

## SECTION IX

### PERFORMANCE EVALUATION SAMPLES

Although intralaboratory QC may demonstrate Contractor and method performance that can be tracked over time, an external performance evaluation program is an essential feature of a QA program. As a means of measuring Contractor and method performance, Contractors participate in interlaboratory comparison studies conducted by the EPA. Results from the analysis of these performance evaluation samples (PES) will be used by the EPA to verify the Contractor's continuing ability to produce acceptable analytical data. The results are also used to assess the precision and accuracy of the analytical methods for specific analytes.

Sample sets may be provided to participating Contractors as frequently as on an SDG-by-SDG basis as a recognizable QC sample of known composition; as a recognizable QC sample of unknown composition; or not recognizable as a QC material. The laboratory evaluation samples may be sent either by the Regional client or the National Program Office, and may be used for contract action.

Contractors are required to analyze the samples and return the data package and all raw data within the contract required turnaround time.

In addition to PES preparation and analysis, the Contractor will be responsible for correctly identifying and quantifying the analytes included in the PES. The Agency will notify the Contractor of unacceptable performance.

Contractors are required to analyze the samples and return the data package and all raw data within the contract required turnaround time.

A Contractor's results on the laboratory evaluation samples will determine the Contractor's performance as follows:

1. Acceptable, No Response Required (Score greater than or equal to 90 percent):

Data meets most or all of the scoring criteria. No response is required.

2. Acceptable, Response Explaining Deficiency(ies) Required (Score greater than or equal to 75 percent but less than 90 percent):

Deficiencies exist in the Contractor's performance.

Within 14 days of receipt of notification from EPA, the Contractor shall describe the deficiency(ies) and the action(s) taken to correct the deficiency(ies) in a letter to the Administrative Project Officer, the Technical Project Officer and EMSL/LV.

An alternate delivery schedule may be proposed by the Contractor, but it is the sole decision of the Agency, represented either by the Technical Project Officer or Administrative Project Officer, to approve



or disapprove the alternate delivery schedule. If an alternate delivery schedule is proposed, the Contractor shall describe in a letter to the Technical Project Officer, Administrative Project Officer, and the Contracting Officer why he/she is unable to meet the delivery schedule listed in this section. The Technical Project Officer /Administrative Project Officer will not grant an extension for greater than 14 days for the Contractor's response letter to the laboratory evaluation sample report. The Contractor shall proceed and not assume that an extension will be granted until so notified by the TPO and/or APO.

If new SOPs are required to be written or SOPs are required to be amended because of the deficiencies and the subsequent corrective action implemented by the Contractor, the Contractor shall write/amend and submit the SOPs per the requirements listed in Exhibit E, Section IV.

3. Unacceptable Performance. Response Explaining Deficiency(ies) Required  
(Score less than 75 percent):

Deficiencies exist in the Contractor's performance to the extent that the National Program Office has determined that the Contractor has not demonstrated the capability to meet the contract requirements.

Within 14 days of receipt of notification from EPA, the Contractor shall describe the deficiency(ies) and the action(s) taken to correct the deficiency(ies) in a letter to the Administrative Project Officer, the Technical Project Officer and EMSL/LV.

An alternate delivery schedule may be proposed by the Contractor, but it is the sole decision of the Agency, represented either by the Technical Project Officer or Administrative Project Officer, to approve or disapprove the alternate delivery schedule. If an alternate delivery schedule is proposed, the Contractor shall describe in a letter to the Technical Project Officer, Administrative Project Officer, and the Contracting Officer why he/she is unable to meet the delivery schedule listed in this section. The Technical Project Officer /Administrative Project Officer will not grant an extension for greater than 14 days for the Contractor's response letter to the performance evaluation sample report.

If new SOPs are required to be written or SOPs are required to be amended because of the deficiencies and the subsequent corrective action implemented by the Contractor, the Contractor shall write/amend and submit the SOPs per the requirements listed in Exhibit E, Section IV.

The Contractor shall be notified by the Technical Project Officer or Administrative Project Officer concerning the remedy for their unacceptable performance. A Contractor may expect, but the Agency is not limited to, the following actions: reduction of the number of samples sent under the contract, suspension of sample shipment to the Contractor, an On-Site laboratory evaluation, data package audit, remedial performance evaluation sample, and/or a contract sanction, such as a Cure Notice.

Note: A Contractor's prompt response demonstrating that corrective actions have been taken to ensure the Contractor's capability to meet contract requirements may facilitate continuation of full sample delivery.

If the Contractor fails to adhere to the requirements listed in this section, a Contractor may expect, but the Agency is not limited to the following actions: reduction in the number of samples sent under the contract, suspension of sample shipment to the Contractor, an On-Site laboratory evaluation, data package audit, a remedial laboratory evaluation sample and/or contract sanctions, such as a Cure Notice.

## SECTION X

### ON-SITE LABORATORY EVALUATIONS

At a frequency dictated by a contract laboratory's performance, the Administrative Project Officer, Technical Project Officer or their authorized representative will conduct an On-Site laboratory evaluation. On-site laboratory evaluations are carried out to monitor the Contractor's ability to meet selected terms and conditions specified in the contract. The evaluation process incorporates two separate categories: Quality Assurance Evaluation, and an Evidentiary Audit.

#### A. Quality Assurance On-Site Evaluation

Quality assurance evaluators inspect the Contractor's facilities to verify the adequacy and maintenance of instrumentation, the continuity of personnel meeting experience or education requirements, and the acceptable performance of analytical and QC procedures. The Contractor should expect that items to be monitored will include, but not be limited to the following:

- o Size and appearance of the facility
- o Quantity, age, availability, scheduled maintenance and performance of instrumentation
- o Availability, appropriateness, and utilization of the QAP and SOPs
- o Staff qualifications, experience, and personnel training programs
- o Reagents, standards, and sample storage facilities
- o Standard preparation logbooks and raw data
- o Bench sheets and analytical logbook maintenance and review
- o Review of the Contractor's sample analysis/data package inspection/data management procedures

Prior to an On-Site evaluation, various documentation pertaining to performance of the specific Contractor is integrated in a profile package for discussion during the evaluation. Items that may be included are previous On-Site reports, performance evaluation sample scores, Regional review of data, Regional QA materials, data audit reports, results of CCS, and data trend reports.

#### B. Evidentiary Audit

Evidence auditors conduct an On-Site laboratory evaluation to determine if laboratory policies and procedures are in place to satisfy evidence handling requirements as stated in Exhibit F. The evidence audit is comprised of the following three activities:

##### 1. Procedural Audit

The procedural audit consists of review and examination of actual standard operating procedures and accompanying documentation for the following laboratory operations: sample receiving, sample

storage, sample identification, sample security, sample tracking (from receipt to completion of analysis) and analytical project file organization and assembly.

2. Written SOPs Audit

The written SOPs audit consists of review and examination of the written SOPs to determine if they are accurate and complete for the following laboratory operations: sample receiving, sample storage, sample identification, sample security, sample tracking (from receipt to completion of analysis) and analytical project file organization and assembly.

3. Analytical Project File Evidence Audit

The analytical project file evidence audit consists of review and examination of the analytical project file documentation. The auditors review the files to determine:

- o The accuracy of the document inventory
- o The completeness of the file
- o The adequacy and accuracy of the document numbering system
- o Traceability of sample activity
- o Identification of activity recorded on the documents
- o Error correction methods

C. Discussion of the On-Site Team's Findings

The quality assurance and evidentiary auditors discuss their findings with the Administrative Project Officer/Technical Project Officer prior to debriefing the Contractor. During the debriefing, the auditors present their findings and recommendations for corrective actions necessary to the Contractor personnel.

D. Corrective Action Reports For Follow-Through to Quality Assurance and Evidentiary Audit Reports

On-site laboratory evaluation:

Following an On-Site laboratory evaluation, quality assurance and/or evidentiary audit reports which discuss deficiencies found during the On-Site evaluation may be sent to the Contractor. In a detailed letter, the Contractor shall discuss the corrective actions implemented to resolve the deficiencies discussed during the On-Site evaluation and discussed in the report(s) to the Technical Project Officer, Administrative Project Officer, and EMSL/LV (response to quality assurance/technical report) and NEIC (response to the evidentiary report), within 14 days of receipt of the report. An alternate delivery schedule may be proposed by the Contractor, but it is the sole decision of the Agency, represented either by the Technical Project Officer or Administrative Project Officer, to approve or disapprove the alternate delivery schedule. If an alternate delivery schedule is proposed, the Contractor shall describe in a letter to the Technical



Project Officer, Administrative Project Officer, and the Contracting Officer why he/she is unable to meet the delivery schedule listed in this section. The Technical Project Officer/Administrative Project Officer will not grant an extension for greater than 14 days for the Contractor's response letter to the quality assurance and evidentiary audit report. The Contractor shall proceed and not assume that an extension will be granted until so notified by the TPO and/or APO.

If new SOPs are required to be written or SOPs are required to be amended because of the deficiencies and the subsequent corrective action implemented by the Contractor, the Contractor shall write/amend and submit the SOPs per the requirements listed in Exhibit E, Section IV.

#### Corrective actions

If the Contractor fails to adhere to the requirements listed in this section, the Contractor may expect, but the Agency is not limited to the following actions: reduction in the number of samples sent under the contract, suspension of sample shipment to the Contractor, an On-Site laboratory evaluation, data package audit, a remedial performance evaluation sample, and/or contract sanctions, such as a Cure Notice.

## SECTION XI

### DATA MANAGEMENT

Data management procedures are defined as procedures specifying the acquisition or entry, update, correction, deletion, storage and security of computer readable data and files. These procedures should be in written form and contain a clear definition for all databases and files used to generate or resubmit deliverables. Key areas of concern include: system organization (including personnel and security), documentation operations, traceability and quality control.

Data manually entered from hard-copy must be quality controlled and the error rates estimated. Systems should prevent entry of incorrect or out-of-range data and alert data entry personnel of errors. In addition, data entry error rates must be estimated and recorded on a monthly basis by reentering a statistical sample of the data entered and calculating discrepancy rates by data element.

The record of changes in the form of corrections and updates to data originally generated, submitted, and/or resubmitted must be documented to allow traceability of updates. Documentation must include the following for each change:

- o Justification or rationale for the change.
- o Initials of the person making the change or changes. Data changes must be implemented and reviewed by a person or group independent of the source generating the deliverable.
- o Change documentation must be retained according to the schedule of the original deliverable.
- o Resubmitted diskettes or other deliverables must be reinspected as a part of the laboratories' internal inspection process prior to resubmission. The entire deliverable, not just the changes, must be inspected.
- o The Laboratory Manager must approve changes to originally submitted deliverables.
- o Documentation of data changes may be requested by laboratory auditors.

Lifecycle management procedures must be applied to computer software systems developed by the laboratory to be used to generate and edit contract deliverables. Such systems must be thoroughly tested and documented prior to utilization.

- o A software test and acceptance plan including test requirements, test results and acceptance criteria must be developed, followed, and available in written form.
- o System changes must not be made directly to production systems generating deliverables. Changes must be made first to a development system and tested prior to implementation.
- o Each version of the production system will be given an identification number, date of installation, date of last operation and archived.

- o System and operations documentation must be developed and maintained for each system. Documentation must include a users manual and an operations and maintenance manual.

Individual(s) responsible for the following functions must be identified:

- o System operation and maintenance including documentation and training.
- o Database integrity, including data entry, data updating and quality control.
- o Data and system security, backup and archiving.

EXHIBIT F

CHAIN-OF-CUSTODY, DOCUMENT CONTROL,  
AND STANDARD OPERATING PROCEDURES





## 1. SAMPLE CHAIN-OF-CUSTODY

A sample is physical evidence collected from a facility or from the environment. Controlling evidence is an essential part of the hazardous waste investigation effort. To accomplish this, Contractors are required to develop and implement the following sample identification, chain-of-custody, sample receiving, and sample tracking procedures.

### 1.1 Sample Identification

To assure traceability of the samples while in possession of the Contractor, the Contractor shall have a specified method for maintaining identification of samples throughout the laboratory.

Each sample and sample preparation container shall be labeled with the EPA number or a unique laboratory identifier. If a unique laboratory identifier is used, it shall be cross-referenced to the EPA number.

### 1.2 Chain-of-Custody Procedures

Because of the nature of the data being collected, the custody of EPA samples must be traceable from the time the samples are collected until they are introduced as evidence in legal proceedings. The Contractor shall have procedures ensuring that EPA sample custody is maintained and documented. A sample is under custody if:

- o It is in your possession, or
- o It is in your view after being in your possession, or
- o It was in your possession and you locked it up, or
- o It is in a designated secure area. (Secure areas shall be accessible only to authorized personnel.)

### 1.3 Sample Receiving Procedures

- 1.3.1 The Contractor shall designate a sample custodian responsible for receiving all samples.
- 1.3.2 The Contractor shall designate a representative to receive samples in the event that the sample custodian is not available.
- 1.3.3 The condition of the shipping containers and sample bottles shall be inspected upon receipt by the sample custodian or his/her representative.
- 1.3.4 The condition of the custody seals (intact/not intact) shall be inspected upon receipt by the sample custodian or his/her representative.
- 1.3.5 The sample custodian or his/her representative shall check for the presence or absence of the following documents accompanying the sample shipment:

- o Airbills or airbill stickers
  - o Custody seals
  - o EPA custody records
  - o EPA traffic reports or SAS packing lists
  - o Sample tags
- 1.3.6 The sample custodian or his/her representative shall sign and date all forms (e.g., custody records, traffic reports or packing lists, and airbills) accompanying the samples at the time of sample receipt.
- 1.3.7 The Contractor shall contact the Sample Management Office (SMO) to resolve discrepancies and problems such as absent documents, conflicting information, broken custody seals, and unsatisfactory sample condition (e.g., leaking sample bottle).
- 1.3.8 The Contractor shall record the resolution of discrepancies and problems on Telephone Contact Logs.
- 1.3.9 The following information shall be recorded on Form DC-1 (See Exhibit B) by the sample custodian or his/her representative as samples are received and inspected:
- o Condition of the shipping container
  - o Presence or absence and condition of custody seals on shipping and/or sample containers
  - o Custody seal numbers, when present
  - o Condition of the sample bottles
  - o Presence or absence of airbills or airbill stickers
  - o Airbill or airbill sticker numbers
  - o Presence or absence of EPA custody records
  - o Presence or absence of EPA traffic reports or SAS packing lists
  - o Presence or absence of sample tags
  - o Sample tag identification numbers cross-referenced to the EPA sample numbers
  - o Verification of agreement or non-agreement of information recorded on shipping documents and sample containers
  - o Problems or discrepancies
- 1.4 Sample Tracking Procedures

The Contractor shall maintain records documenting all phases of sample handling from receipt to final analysis.

## 2. DOCUMENT CONTROL PROCEDURES

The goal of the laboratory document control program is to assure that all documents for a specified Sample Delivery Group (SDG) will be accounted for when the project is completed. Accountable documents used by contract laboratories shall include, but not be limited to, logbooks, chain-of-custody records, sample work sheets, bench sheets, and other documents relating to the sample or sample analyses. The following document control procedures have been established to assure that all laboratory records are assembled and stored for delivery to EPA or are available upon request from EPA prior to the delivery schedule.

### 2.1 Preprinted Laboratory Forms and Logbooks

- 2.1.1 All documents produced by the Contractor which are directly related to the preparation and analysis of EPA samples shall become the property of the EPA and shall be placed in the complete sample delivery group file (CSF). All observations and results recorded by the laboratory but not on preprinted laboratory forms shall be entered into permanent laboratory logbooks. When all data from a SDG is compiled, all original laboratory forms and copies of all SDG-related logbook entries shall be included in the documentation package.
- 2.1.2 The Contractor shall identify the activity recorded on all laboratory documents which are directly related to the preparation and analysis of EPA samples.
- 2.1.3 Pre-printed laboratory forms shall contain the name of the laboratory and be dated (month/day/year) and signed by the person responsible for performing the activity at the time an activity is performed.
- 2.1.4 Logbook entries shall be dated (month/day/year) and signed by the person responsible for performing the activity at the time an activity is performed.
- 2.1.5 Logbook entries shall be in chronological order. Entries in logbooks, with the exception of instrument run logs and extraction logs, shall include only one SDG per page.
- 2.1.6 Pages in both bound and unbound logbooks shall be sequentially numbered.
- 2.1.7 Instrument run logs shall be maintained so as to enable a reconstruction of the run sequence of individual instruments.

Because the laboratory must provide copies of the instrument run logs to EPA, the laboratory may exercise the option of using only laboratory or EPA sample identification numbers in the logs for sample ID rather than government agency or commercial client names to preserve the confidentiality of commercial clients.



2.1.8 Corrections to supporting documents and raw data shall be made by drawing a single line through the error and entering the correct information. Corrections and additions to supporting documents and raw data shall be dated and initialed. No information shall be obliterated or rendered unreadable.

All notations shall be recorded in ink.

Unused portions of documents shall be "z'd" out.

## 2.2 Consistency of Documentation

The Contractor shall assign a document control officer responsible for the organization and assembly of the CSF.

All copies of laboratory documents shall be complete and legible.

Original documents which include information relating to more than one SDG shall be filed in the CSF of the lowest SDG number. The copy(s) shall be placed in the other CSF(s) and the Contractor shall record the following information on the copy(s) in red ink:

"COPY

ORIGINAL IS FILED IN CSF \_\_\_\_\_"

The Contractor shall sign and date this addition to the copy(s).

Before releasing analytical results, the document control officer shall assemble and cross-check the information on samples tags, custody records, lab bench sheets, personal and instrument logs, and other relevant deliverables to ensure that data pertaining to each particular sample or sample delivery group is consistent throughout the CSF.

## 2.3 Document Numbering and Inventory Procedure

In order to provide document accountability of the completed analysis records, each item in the CSF shall be inventoried and assigned a serialized number as described in Exhibit B).

All documents relevant to each sample delivery group, including logbook pages, bench sheets, mass spectra, chromatograms, screening records, re-preparation records, re-analysis records, records of failed or attempted analysis, custody records, library research results, etc. shall be inventoried.

The Document Control Officer (DCO) shall be responsible for ensuring that all documents generated are placed in the CSF for inventory and are delivered to the appropriate EPA region or other receiver as designated by EPA. The DCO shall place the sample tags in plastic bags in the file.

#### 2.4 Storage of EPA Files

The Contractor shall maintain EPA laboratory documents in a secure location.

#### 2.5 Shipment of Deliverables

The Contractor shall document shipment of deliverables packages to the recipients. These shipments require custody seals on the containers placed such that they cannot be opened without damaging or breaking the seal. The Contractor shall document what was sent, to whom, the date, and the method (carrier) used.

A copy of the transmittal letter for the CSF shall be sent to the NEIC/CEAT and the SMO.

### 3. SPECIFICATIONS FOR WRITTEN STANDARD OPERATING PROCEDURES

The Contractor shall have written standard operating procedures (SOPs) for receipt of samples, maintenance of custody, sample identification, sample storage, sample tracking, and assembly of completed data.

An SOP is defined as a written narrative stepwise description of laboratory operating procedures including examples of laboratory documents. The SOPs shall accurately describe the actual procedures used in the laboratory, and copies of the written SOPs shall be available to the appropriate laboratory personnel. These procedures are necessary to ensure that analytical data produced under this contract are acceptable for use in EPA enforcement case preparation and litigation. The Contractor's SOPs shall provide mechanisms and documentation to meet each of the following specifications and shall be used by EPA as the basis for laboratory evidence audits.

- 3.1 The Contractor shall have written SOPs describing the sample custodian's duties and responsibilities.
- 3.2 The Contractor shall have written SOPs for receiving and logging in of the samples. The procedures shall include but not be limited to documenting the following information:
  - 3.2.1 Presence or absence of EPA chain-of-custody forms
  - 3.2.2 Presence or absence of airbills or airbill stickers
  - 3.2.3 Presence or absence of traffic reports or SAS packing lists
  - 3.2.4 Presence or absence of custody seals on shipping and/or sample containers and their condition
  - 3.2.5 Custody seal numbers, when present
  - 3.2.6 Airbill or airbill sticker numbers
  - 3.2.7 Presence or absence of sample tags

- 3.2.8 Sample tag ID numbers
  - 3.2.9 Condition of the shipping container
  - 3.2.10 Condition of the sample bottles
  - 3.2.11 Verification of agreement or non-agreement of information on receiving documents and sample containers
  - 3.2.12 Resolution of problems or discrepancies with the SMO
  - 3.2.13 An explanation of any terms used by the laboratory to describe sample condition upon receipt (e.g., good, fine, OK)
- 3.3 The Contractor shall have written SOPs for maintaining identification of EPA samples throughout the laboratory.

If the Contractor assigns unique laboratory identifiers, written SOPs shall include a description of the method used to assign the unique laboratory identifier and shall include a description of the document used to cross-reference the unique laboratory identifier to the EPA sample number.

If the Contractor uses prefixes or suffixes in addition to sample identification numbers, the written SOPs shall include their definitions.

- 3.4 The Contractor shall have written SOPs describing all storage areas for samples in the laboratory. The SOPs shall include a list of authorized personnel who have access or keys to secure storage areas.
- 3.5 The Contractor shall have written SOPs describing the method by which the laboratory maintains samples under custody.
- 3.6 The Contractor shall have written SOPs describing the method by which the laboratory maintains the security of any areas identified as secure.
- 3.7 The Contractor shall have written SOPs for tracking the work performed on any particular samples. The tracking SOP shall include:
- o A description of the documents used to record sample receipt, sample storage, sample transfers, sample preparations, and sample analyses.
  - o A description of the documents used to record calibration and QA/QC laboratory work.
  - o Examples of document formats and laboratory documents used in the sample receipt, sample storage, sample transfer, and sample analyses.
  - o A narrative step-wise description of how documents are used to track samples.



3.8 The Contractor shall have written SOPs for organization and assembly of all documents relating to each SDG. Documents shall be filed on a sample delivery group-specific basis. The procedures shall ensure that all documents including logbook pages, sample tracking records, chromatographic charts, computer printouts, raw data summaries, correspondence, and any other written documents having reference to the SDG are compiled in one location for submission to EPA. The written SOPs shall include:

- o A description of the numbering and inventory method.
- o A description of the method used by the laboratory to verify consistency and completeness of the CSF.
- o Procedures for the shipment of deliverables packages using custody seals.

4. HANDLING OF CONFIDENTIAL INFORMATION

A Contractor conducting work under this contract may receive EPA-designated confidential information from the agency. Confidential information must be handled separately from other documentation developed under this contract. To accomplish this, the following procedures for the handling of confidential information have been established.

4.1 All confidential documents shall be under the supervision of a designated Document Control Officer (DCO).

4.2 Confidential Information

Any samples or information received with a request of confidentiality shall be handled as "confidential." A separate locked file shall be maintained to store this information and shall be segregated from other nonconfidential information. Data generated from confidential samples shall be treated as confidential. Upon receipt of confidential information, the DCO will log these documents into a Confidential Inventory Log. The information will then be available to authorized personnel but only after it has been signed out to that person by the DCO. The documents shall be returned to the locked file at the conclusion of each working day. Confidential information may not be reproduced except upon approval by the EPA Administrative or Technical Project Officer. The DCO will enter all copies into the document control system described above. In addition, this information may not be disposed of except upon approval by the EPA Administrative or Technical Project Officer. The DCO shall remove and retain the cover page of any confidential information disposed of for one year and shall keep a record on the disposition in the Confidential Inventory Log.





## **ACID/BASE ACCOUNTING**

**SULFUR FRACTIONS, LABORATORY METHODS APPLICABLE TO  
OVERBURDEN AND MINESOILS  
(EPA, 1978)**

**NEUTRALIZATION POTENTIAL, MINE SPOIL POTENTIALS FOR  
SOIL AND WATER QUALITY  
(EPA, 1974)**

**EXCHANGEABLE ACIDITY, METHODS OF SOIL ANALYSIS  
(SSSA, 1982)**

**SMP BUFFER, METHODS OF SOIL ANALYSIS  
(SSSA, 1982)**



### 3.2.3 Neutralization Potential

#### 3.2.3.1 Principles

The amount of neutralizing bases, including carbonates, present in overburden materials is found by treating a sample with a known excess of standardized hydrochloric acid. The sample and acid are heated to insure that the reaction between the acid and the neutralizers goes to completion.

The calcium carbonate equivalent of the sample is obtained by determining the amount of unconsumed acid by titration with standardized sodium hydroxide (Jackson, 1958).

#### 3.2.3.2 Comments--

A fizz rating of the neutralization potential is made for each sample to insure the addition of sufficient acid to react all the calcium carbonate present.

During digestion, do not boil samples. If boiling occurs, discard sample and rerun. Before titrating with acid, fill buret with acid and drain completely. Before titrating with base, fill buret with base and drain completely to assure that free titrant is being added to the sample.

#### 3.2.3.3 Chemicals--

1. Carbon dioxide-free water: Heat distilled water just to boiling in a beaker. Allow to cool slightly and pour into a container equipped with ascarite tube. Cool to room temperature before using.
2. Hydrochloric acid (HCl) solution, 0.1N, certified grade (Fisher So-A-54 or equivalent).
3. Sodium hydroxide (NaOH), approximately 0.5 N: Dissolve 20.0g of NaOH pellets in carbon dioxide-free water and dilute to 1 liter. Protect from CO<sub>2</sub> in the air with ascarite tube. Standardized solution by placing 50 ml of certified 0.1 N HCl in a beaker and titrating with the prepared 0.5 N NaOH until a pH of 7.00 is obtained. Calculate the Normality of the NaOH using the following equation:

$$N_2 = (N_1 V_1) / V_2, \text{ where:}$$

V<sub>1</sub> = Volume of HCl used.



N1 = Normality of HCl used.  
V2 = Volume of NaOH used.  
N2 = Calculated Normality of NaOH.

4. Sodium hydroxide (NaOH) approximately 0.1 N: Dilute 200 ml of 0.5 N NaOH with carbon dioxide-free water to a volume of 1 liter. Protect from CO<sub>2</sub> in air with ascarite tube. Standardized solution by placing 20 ml of certified 0.1 N HCl in a beaker and titrating with the prepared 0.1 N NaOH until a pH of 7.00 is obtained. Calculate the Normality of NaOH using the same equation in 3.2.3.3 No. 3.
5. Hydrochloric acid (HCl), approximately 0.5 N: Dilute 42 ml of concentrated HCl to a volume of 1 liter with distilled water. Standardized solution by placing 20 ml of the known Normality NaOH prepared in no. 3 in a beaker and titrating with the prepared HCl until a pH of 7.00 is obtained. Calculate the Normality of the HCl using the following equation:

$$N1 = (N2V2)/V1, \text{ where:}$$

V2 = Volume of NaOH used.  
N2 = Normality of NaOH used.  
V1 = Volume of HCl used.  
N1 = Calculated Normality of HCl.

6. Hydrochloric acid (HCl), approximately 0.1 N: Dilute 200 ml of 0.5 N HCl to a volume of 1 liter with distilled water. Standardized solution as in 3.2.3.3 No.5, but use 20 ml of the known Normality NaOH prepared in 3.2.3.3 No. 4.
7. Hydrochloric acid (HCl), 1 part acid to 3 parts water: Dilute 250 ml of concentrated HCl with 750 ml of distilled water.

#### 3.2.3.4 Materials--

1. Flasks, Erlenmeyer, 250 ml.
2. Buret, 100 ml (one required for each acid and one for each base).
3. Hotplate, steam bath can be substituted.
4. pH meter (Corning Model 12 or equivalent) equipped with combination electrode.
5. Balance, can be read to 0.01g.

#### 3.2.3.5 Procedure--

1. Place approximately 0.5g of sample (less than 60 mesh) on a

piece of aluminum foil.

2. Add one or two drops of 1:3 HCl to the sample. The presence of  $\text{CaCO}_3$  is indicated by a bubbling or audible "fizz."
3. Rate the bubbling or "fizz" in step 2 as indicated in Table 1.
4. Weigh 2.00g of sample (less than 60 mesh) into a 250 ml Erlenmeyer flask.
5. Carefully add HCl indicated by Table 1 into the flask containing sample.
6. Heat nearly to boiling, swirling flask every 5 minutes, until reaction is complete. NOTE: Reaction is complete when no gas evolution is visible and particles settle evenly over the bottom of the flask.

TABLE 1. VOLUME AND NORMALITY OF HYDROCHLORIC ACID USED FOR EACH FIZZ RATING

| =====       |      |             |
|-------------|------|-------------|
| HC1         |      |             |
| Fizz Rating | (ml) | (Normality) |
| -----       |      |             |
| None        | 20   | 0.1         |
| Slight      | 40   | 0.1         |
| Moderate    | 40   | 0.5         |
| Strong      | 80   | 0.5         |
| =====       |      |             |

7. Add distilled water to make a total volume of 125 ml.
8. Boil contents of flask for one minute and cool to slightly above room temperature. CAUTION: Do not place rubber stopper in hot flask as it may implode upon cooling.
9. Titrate using 0.1 N NaOH or 0.5 N NaOH (concentrate exactly known), to pH 7.0 using an electrometric pH meter and buret. The concentration of NaOH used in the titration should correspond to the concentration of the HCl used in step 5. NOTE: Titrate with NaOH until a constant reading of pH 7.0 remains for at least 30 seconds.

10. If less than 3 ml of the NaOH is required to obtain a pH of 7.0, it is likely that the HCl added was not sufficient to neutralize all of the base present in the 2.00g sample. A duplicate sample should be run using the next higher volume or concentration of acid as indicated in Table 1.
11. Run a blank for each volume or normality of acid using steps 5, 7, 8, and 9.

#### 3.2.3.6 Calculations--

1. Constant (C) = (ml acid in blank)/(ml base in blank).
2. ml acid consumed = (ml acid added) - (ml base added X C).
3. Tons CaCO<sub>3</sub> equivalent/thousand tons of material = (ml of acid consumed) X (25.0) X (N of acid).

### 3.2.4 Maximum Potential Acidity by Total Sulfur Determination

#### 3.2.4.1 Principles--

This method measures the total sulfur in a sample. If all of the total sulfur in pyritic forms, the calculation of maximum potential acidity from sulfur corresponds with actual potential acidity from sulfur. But if part of the sulfur occurs in other forms, the maximum as calculated will be too high. This is the reason that such calculations are referred to as maximums and in doubtful cases approximate determinations should be made which rule out other sulfur forms (see 3.2.6). These determinations are not necessary when the maximum acid from total sulfur is within safe limits.

A sample is heated to approximately 1600 C. A stream of oxygen is passed through the sample during the heating period. Sulfur dioxide is released from the sample and collected in a dilute hydrochloric acid solution containing potassium iodide, starch, and a small amount of potassium iodate. This solution is automatically titrated with a standard potassium iodate solution.

A trace amount of potassium iodate reacts with potassium iodide and dilute hydrochloric acid to yield free iodine, potassium chloride and water. The free iodine combines with the sulfur dioxide and water to yield sulfuric acid and hydroiodic acid. The amount of potassium iodate solution used during the titration is recorded. The calculation of the percent total sulfur is based on the potassium iodate measurement (Smith et al., 1974).

#### 3.2.4.2 Comments--

Some samples, e.g. coal, when first placed in the furnace may change the color of the solution in the titration vessel to pink or purple (probably due to organic compounds). Some samples may contain halogens (iodine, chlorine, fluorine) which darken the solution in the titration vessel and will therefore produce results that are low. The halogen problem, if encountered, may be eliminated by the use of an antimony trap between the furnace and titration assembly. Interference may result with samples high in nitrogen; however, this does not appear to happen with rock samples. Additional information can be obtained by reading Leco Equipment Application 120 and Instructions for Analysis of Sulfur in Hydrocarbons by the Leco High Frequency Combustion Titration Procedure.

materials with a low chroma (2 or less) may have a high (over 1.0 %) sulfur content; therefore, use a 0.250g sample when the chroma of the material is 1 or 2. If the chroma of the material is zero, a 0.100g sample is used. If sulfur is not detectable or

more accurate values are desired in this sample size, increase to next highest sample size and rerun.



Read entire manuals on both the Leco Induction Furnace and the Automatic Titrator.

Periodically clean titration chamber and associated glassware with acetone or concentrated hydrochloric acid and rinse thoroughly with distilled water.

The following procedure is for use with a LECO Induction Furnace, Model 521 with Automatic Sulfur Titrator, Model 532. Other similar or advanced models of this instrumentation may perform equally well; however, the following procedure will require detailed modifications by a qualified person for application to other instruments.

#### 3.2.4.3 Chemicals--

1. Iron chip accelerator (Leco number 501-077).
2. Iron powder accelerator (Leco number 501-078).
3. Copper ring (Leco number 550-189).
4. Magnesium oxide (Mgo).
5. Potassium iodate ( $KIO_3$ ), 0.0052 N: Dissolve 1.110g  $KIO_3$  in distilled water and dilute to 1 liter.
6. Hydrochloric acid ( $HCl$ ) solution: Dilute 15 ml of concentrated  $HCl$  to a volume of 1 liter with distilled water.
7. Arrowroot starch solution: Dissolve 4.0g of arrowroot starch (Leco number 501-061) in 100 ml of distilled water in a 250 ml beaker. Stir on a mechanical stirrer with a stirring bar. While starch is stirring, boil 300 ml of distilled and deionized water in a 600 ml beaker. Remove from heat when boiling point is reached. Remove starch from stirrer. Place boiled water on mechanical stirrer with stirring bar. While water is continually stirring, add 5 ml of starch mixture in 20 second intervals until all starch solution has been added. Place a small amount of the solution in the 600 ml beaker back into the 250 ml beaker that contained the starch mixture. Wash beaker by hard swirling and then pour contents back into the 600 ml beaker. Continue stirring solution in the 600 ml beaker allowing solution to cool to 40°C. Add 12.0g of potassium iodide ( $KI$ ). Continue stirring for 15 to 20 minutes.
8. Potassium iodide ( $KI$ ).
9. Sulfur standards (Leco number 501-502).

#### 3.2.4.4 Materials--

1. Leco Automatic sulfur analyzer, package unit, number 634-700.
2. Scoops, 0.2 ml volume.
3. Ceramic crucibles with porous covers.
4. Carboys, 19 liters (5 gal).
5. Tongs.
6. Glass wool.
7. Oxygen regulators.
8. Mechanical stirrer.
9. Stirring bar.
10. Combustion tube, hydrocarbon (Leco number 519-004).
11. Hot plate.
12. Balance, can be read to 0.001g.

#### 3.2.4.5 Procedure-- (revised and updated from Smith et al., 1974)--

NOTE: Read entire manuals on Leco Furnace, Automatic Titrator and this entire procedure before starting.

1. Place one level scoop of iron chips in crucible.
2. Weigh 0.500g of sample (less than 60 mesh) onto the crucible.

NOTE: For samples that are suspected to contain over 1% sulfur or have a chroma of less than 2, see "comments".

3. Add one scoop MgO.
4. Add one copper ring and then one scoop of iron powder.
5. Gently shake the crucible to evenly cover the bottom and place one porous cover on the crucible.
6. Turn on "Filament Voltage" grid tap to medium position.

7. Wait for one minute then turn "High Voltage" switch ON.
8. Set "Titrate-Endpoint" switch to its middle position.
9. Turn on titrator (upper left switch above "Endpoint Adjust").
10. Drain "Titration Vessel" completely.
11. Set timer switch to ON, adjust timer to 10 minutes, or a time sufficient to satisfy steps 25, 26, and 27.
12. Slosh carboys containing HCl and KIO<sub>3</sub> to mix the condensate on the walls of the container.
13. Fill "Iodate Buret."
14. Fill "Titration Vessel" approximately one-third full with the HCl solution.
15. Turn on oxygen. Set the pressure to 15 psi, and the flow rate to 1.0 liter per minute. NOTE: Oxygen flow must be started before starch is added.
16. Raise the "Locking Mechanism Handle" WITHOUT a sample crucible on the pedestal, and lock in place. NOTE: Make sure there is an airtight contact between sample platform and combustion chamber by observing a vigorous bubbling in the "Titration Vessel" chamber.
17. Add one measure (5ml) of starch solution. NOTE: If solution in "Titration Vessel" chamber turns turbid or yellow after starch solution is added, turn off the instrument following steps 33 through 39 and make NEW starch solution.
18. Set "Titrate-Endpoint" switch to middle position and lower "Locking Mechanism Handle."
19. After a few seconds when titrant level in "Iodate Buret" has stopped falling (Buret reading should be no more than 0.004) the solution in the "Titration Vessel" chamber should be a deep blue. NOTE: If the solution is a pale blue or almost black, turn off the instrument following steps 33 through 39 and make NEW starch solution.
20. Set "Titrate-Endpoint" switch to middle position and lower "Locking Mechanism Handle."
21. Refill "Iodate Buret."
22. Place sample crucible on pedestal, making sure it is centered, and carefully raise "Locking Mechanism Handle" and lock in place.

NOTE: Make sure there is an airtight contact between sample platform and combustion chamber by observing a vigorous bubbling in the "Titration Vessel" chamber.

23. Set "Titrate-Endpoint" switch to Titrate, or if it is known that sample will evolve  $\text{SO}_2$  slowly, set switch at endpoint. The Endpoint setting acts as a "Fine Control" allowing buret valve to discriminate smaller increments.
24. Push RED button on timer to start analysis.
25. Plate current must go to 400-450 ma for at least 2 minutes during the analysis; if not, reweigh and rerun sample.
26. Adjust rheostat to prevent plate current from exceeding 450 ma.
27. When buret reading does not change for 2 minutes, and Plate Current has achieved 400 to 450 ma, it can be assumed that all of the sulfur has been removed from the sample. If buret reading is still changing when timer shuts off instrument, set Timer Switch to OFF, which restarts furnace, leave furnace on until buret is stable for 2 minutes, then turn Timer Switch to ON.
28. Set "Titrate-Endpoint" to middle position. IMPORTANT: Record titration reading.
29. Lower sample platform, remove crucible using tongs, place fresh sample crucible in place, but do not close sample chamber.

NOTE: Slightly drain titrating chamber to maintain original level. Drain, flush, and refill titrating chamber every 3rd sample, or more often if a large quantity of titrant was used by the previous sample (steps 16-22).

30. Refill  $\text{KIO}_3$  buret.
31. Close sample chamber, making sure it is tight. Check endpoint (steps 18, 19 and 21).
32. Go to step 23 and continue until all samples have been processed.
33. Turn "Titrate-Endpoint" switch to mid position.
34. Turn off main  $\text{O}_2$  valve on top of tank.
35. Turn off "High Voltage."
36. Turn off Automatic Titrator.



37. Drain titration chamber; flush twice with a chamber full of HCl solution or water, cover and leave chamber full of HCl solution.
38. If O<sub>2</sub> has stopped bubbling in the purifying train, turn off small knurled valve on gauge outlet.
39. Turn off "Filament Voltage."

#### 3.2.4.6 Calculations--

1. Percent sulfur. NOTE: Percent sulfur is dependent upon the concentration of potassium iodate titrant and sample size.
  - A. Using 1.110g KIO<sub>3</sub>/L and 0.500g sample (0.005 - 1.00% sulfur range) %S = Buret reading X 5.0.
  - B. Using 1.110g KIO<sub>3</sub>/L and 0.250g sample (0.010 - 2.00% sulfur range) %S = Buret reading X 10.0.
  - C. Using 1.110g KIO<sub>3</sub>/L and 0.100g sample (0.025 - 5.00% sulfur range) %S = Buret reading X 25.0.
2. To convert % sulfur to maximum CaCO<sub>3</sub> equivalents: Multiply % sulfur by 31.25 to get tons CaCO<sub>3</sub> equivalent/1000 tons of material.

### 3.2.6 HCl-Extractable, HNO3-Extractable and Non-Extractable Total Sulfur

NOTE: Revisions to the original method are underlined.

#### 3.2.6.1 Principles--

In doubtful cases, as stated in 3.2.4.1, this method should be used to rule out HCl-extractable and non-extractable forms of sulfur which are not considered to be acid formers. The HNO3-extractable sulfur is determined by calculations. This form of sulfur will react with oxygen to produce acid. The HCl extractable form may consist of slightly acid-forming sulfates like jarosite.

#### 3.2.6.2 Comments--

It is necessary to remove chlorides and nitrates by water leachings after the hydrochloric and nitric acid (respectively) extractions before running total sulfur.

Care should be taken that no sample is lost by run over, splashing or breaking through the filter paper during all leachings.

#### 3.2.6.3 Chemicals--

1. Hydrochloric acid (HCl), 2 parts acid to 3 parts water: Mix 400 ml of concentrated HCl with 600 ml of distilled water.
2. Nitric acid (HNO3), 1 part acid to 7 parts water: Mix 125 ml of concentrated HNO3 with 875 ml of distilled water.
3. Silver Nitrate (AgNO3), 10%: Dissolve 10.0g of AgNO3 in 90 ml of distilled water. Store in amber bottle away from light.
4. Nessler's Solution (Fisher Scientific Co. No. So-N-24 or equivalent).

#### 3.2.6.4 Materials--

1. Leco Induction Furnace and Automatic Sulfur Titrator as in 3.2.4.4.
2. Funnels, 28 mm I.D. polyethylene.
3. Filter paper, 5.5 cm glass fiber.
4. Flasks, Erlenmeyer, 250 ml.

5. Beakers, 100 ml.
6. Syringe.
7. Balance, can be read to 0.001g.

3.2.6.5 Procedure-- (revised and updated from Smith et al., 1974)

1. Take ~~three~~ four 0.500g subsamples off less than 60 100 mesh material.
2. Take one subsample and analyze for total sulfur (see 3.2.4).
3. Taking care not to sharply crease the glass fibers, fold filter paper to fit a polyethylene funnel.
4. Place second subsample in filter. NOTE: Make sure all material is placed in the filter.
5. Place subsample and filter onto funnel holder in sink or other suitable pan which can receive outflow from funnel.
6. Using a syringe, pipette, or other graduated dispenser, add near boiling H<sub>2</sub>O to almost the top of the filter paper. Caution: During this step and all other leaching steps, be careful not to lose any sample by runover, splashing, or breaking through the filter paper.
7. Repeat step 6 until a total of 100 ml of hot water acid has been added.
8. Place funnel holder, containing funnel and subsample, over a 100 ml beaker.
9. Leach subsample with 50 ml of distilled and deionized water.
10. Measure the EC of leachate. If EC exceeds 100 micromhos/cm, repeat steps 6 through 9 until EC is less than 100 micromhos/cm.
13. Discard leachate.
14. Air dry subsample and filter overnight.
15. Carefully fold glass fiber filter around the sample and transfer to a ceramic crucible for total sulfur analysis (see 3.2.4).
16. Taking care not to sharply crease the glass fibers, fold filter paper to fit a polyethylene funnel.
17. Place second subsample in filter. NOTE: Make sure all

material is placed in the filter.

18. Place subsample and filter onto funnel holder in sink or other suitable pan which can receive outflow from funnel.
19. Using a syringe, pipette, or other graduated dispenser, add 2:3 HCl to almost the top of the filter paper. Caution: During this step and all other leaching steps, be careful not to lose any sample by runover, splashing, or breaking through the filter paper.
20. Repeat step 6 until a total of 50 ml of acid has been added.
21. Place funnel holder, containing funnel and subsample, over a 100 ml beaker.
22. Leach subsample with 50 ml of distilled and deionized water. Discard leachate. NOTE: Stop here if procedure cannot be completed in one day. CAUTION: Samples must be kept moist.
23. Leach subsample with another 50 ml of distilled and deionized water.
24. Test leachate for chlorides by adding 3 drops of 10% AgNO<sub>3</sub> with a dropper. NOTE: The presence of chlorides will be detected by a white precipitate.
25. Discard leachate and repeat steps 23 and 24 until no precipitate forms.
26. Discard leachate.
27. Air dry subsample and filter overnight.
28. Carefully fold glass fiber filter around the sample and transfer to a ceramic crucible for total sulfur analysis (see 3.2.4).
29. Place third subsample in a 250 ml Erlenmeyer flask. NOTE: Make sure all of the subsample is placed in the flask.
30. Add 50 ml of HNO<sub>3</sub> (1:7).
31. Let stand overnight at room temperature Heat to near boiling  
and continue digestion for six hours.
32. Taking care not to sharply crease the glass fibers, fold a filter to fit a polyethylene funnel.
33. Place a funnel holder over a sink or other suitable pan which can receive outflow from funnel.
34. Carefully pour subsample and acid from the Erlenmeyer flask into the funnel. NOTE: Do not get material above top of



filter paper.

35. Repeat step 34 using distilled and deionized water to wash all materials remaining in the Erlenmeyer flask into funnel.
36. Place funnel holder containing funnel and subsample over a 100 ml beaker. NOTE: Stop here if procedure cannot be completed in one day. CAUTION: Sample must be kept moist.
37. Leach subsample with 50 ml of distilled and deionized water. Discard leachate.
38. Leach subsample with another 50 ml of distilled and deionized water.
39. Test leachate for presence of nitrates by adding 3 drops of Nessler's Solution with a dropper. NOTE: If nitrates are present, the leachate will turn yellow within 30 seconds as seen against a white background.
40. Discard leachate and repeat steps 38 and 39 until no nitrates are detected.
41. Discard leachate.
42. Air dry samples and filter overnight.
43. Carefully fold glass fiber filter around the sample and transfer to a ceramic crucible for total sulfur analysis (see 3.2.4).

#### 3.2.6.6 Calculations--

1. Hot water extractable Sulfur (mostly sulfates) = (Total sulfur of untreated sample) minus (Total sulfur after hot water leach)
2. HCl extractable Sulfur (acid dissociable sulfides and less soluble sulfates) = (Total sulfur after water leach) minus (Total sulfur HCl treatment).
3. HNO3 extractable Sulfur (mostly pyrite or other acid-forming sulfides) = (Total sulfur after HCl leach) minus (Total sulfur after HNO3 treatment).
4. Residual Sulfur (mostly organic sulfur Note: should be near zero) = Total sulfur after HNO3 treatment.

## ment Measurements

ory soil tests for determining the LR for a given soil condition and crop, ld experiments. Because of the time-determine LR, they are no longer tant for correlating laboratory test methods to determine lime requirements, soil-base titrations, and soil-

## EQUILIBRATIONS)

of determining LR of soils for wider ided by field studies led to develop-ethod consists of mixing increments brating with the moistened soil, and required to bring a soil to a selected ity is intense under incubation con-  
Ca, Mg, K, etc.) accumulate in the out or otherwise taken into account, rably. Because the time required to ), these methods are time-con-

trated with a base just as any acid is the acidity of a soil is not accessible fence, direct titration is slow. Titrating the soil in a relatively concen-er but more satisfactory titration is a given soil with progressively larger  $\text{Ca}(\text{OH})_2$  (and reciprocal quantities after carbonation, aeration, and ison, 1933).

## NS

ation of soil acidity is how to com-and yet add the base sufficiently ublicting the soil to a much higher ing practice. Thus various buffer that permit neutralization of the onstant pH. Some of the methods r its reaction with the soil (Scho-ely measure the change in pH of a this change in buffer pH being a

## 12-3 LIME REQUIREMENT

measure of the LR of the soil (Adams & Evans, 1962; Brown, 1943; Shoemaker et al., 1962; Woodruff, 1948). The Shoemaker, McLean, and Pratt (SMP), Adams and Evans, and Woodruff methods are widely used in soil testing laboratories as the bases for recommending lime applications for acid soils.

The Woodruff method as originally constituted (Woodruff, 1948) generally underestimates the LR of soils having LR of 2,242 kg/ha (1 ton/acre) or more and may indicate less than half the actual LR in soils of very high LR (McLean et al., 1966). A new buffer now used in the Woodruff method indicates considerably more lime than the original buffer, but unpublished data show that it has a tendency to indicate slightly too much in soils of high LR and considerably too much in soils of low LR. The SMP method has been shown to be especially well adapted for soils that have  $>4,482$  kg/ha (2 tons/acre) LR, have a pH below 5.8, contain  $<10\%$  OM, and have appreciable quantities of soluble Al (McLean et al., 1966). The Adams and Evans method is designed to measure comparatively small magnitudes of LR in Coastal Plain soils of low CEC.

## 12-3.4.4 SMP SINGLE-BUFFER METHOD

12-3.4.4.1 Principles. A buffer solution is generally a mixture of a weak acid and a salt of the same weak acid, which neutralizes both acids and bases, and thus resists marked changes in pH of a system. Yet linear change in pH of a buffer caused by the addition of an acidic substance can be used to indicate the total acidity represented by the change in buffer pH. Since acid soil is itself a buffer, when it is added to a buffer mixture for the purpose of measuring its LR, the resulting two-buffer suspension (soil-buffer) is relatively complex (McLean, 1978). The SMP buffer method as originally proposed is based on a generalized relationship between buffer-indicated and  $\text{CaCO}_3$  incubation-measured LR of a group of soils. Complications in interpreting the changes in buffer pH brought about by mixing soil and buffer stem from the facts that (i) much of the acidity is pH dependent, and (ii) only a fraction of the total soil acidity reacts with the buffer. Specifically, marked change in relative amounts of H ions dissociating from the soil-SMP buffer system at soil-buffer pH 6.9 and above accounts for relatively wide variations between buffer-indicated and  $\text{CaCO}_3$  incubation-measured LR of low LR soils. Similarly, decreased reactivity of  $\text{H}^+$  in high OM soils and increased reactivity of  $\text{H}^+$  in acid-leached soils cause errors in SMP buffer-indicated LR. The double-buffer feature (section 12-3.4.5) improves the SMP buffer method for determining LR by converting buffer-indicated LR values from general relationships of a population of soils to specific relationships for individual soils (McLean et al., 1977).

## 12-3.4.4.2 Equipment and Reagents.

1. pH meter equipped with glass (indicating) and reference electrodes.
2. Standard buffers, pH 7 and 4.
3. Distilled water.



4. Mechanical shaker.
5. Optional equipment and supplies listed in section 12-2.6.4.
6. Shoemaker, McLean, and Pratt (SMP) buffer solution (preparation described separately below).

#### 12-3.4.4.3 Preparation of SMP Buffer.<sup>5</sup>

1. Weigh and place in an 18-liter bottle:
  - a. *p*-Nitrophenol, 32.4 g.
  - b. Potassium chromate ( $K_2CrO_4$ ), 54.0 g.
  - c. Calcium chloride dihydrate ( $CaCl_2 \cdot 2H_2O$ ), 955.8 g.
2. Add approximately 9 liters of distilled water. Shake vigorously as you add the water, and continue shaking for a few minutes to prevent formation of a crust over the salts.
3. Weigh 36.0 g of calcium acetate  $Ca(OAc)_2$  into a separate container, and dissolve in approximately 5 liters of distilled water.
4. Add solution from no. 3 to that of no. 2, shaking as they are combined. Shake every 15 or 20 min for 2 or 3 hours.
5. Add 45 ml of triethanolamine (TEA), again shaking as the addition is made.
6. Shake periodically until the mixture is completely dissolved. This takes approximately 8 hours.
7. Dilute to 18 liters with distilled water.
8. Adjust to pH 7.5 with 15% sodium hydroxide (NaOH) using the standardized pH meter.
9. Filter through a fiberglass sheet or cotton mat.
10. Connect an air inlet with 2.5 by 30 cm cylinder of drierite, 2.5 by 30 cm cylinder of ascarite, and 2.5 by 30 cm cylinder of drierite in series to protect against contamination with  $CO_2$  and water vapor.

**12-3.4.4.4 Procedure.** Standardize the pH meter as described previously (section 12-2.6.1). Since the SMP buffer is adjusted to pH 7.5 and is protected from contamination as indicated, its pH changes very little from day to day. Hence, it can be used as a secondary standard for checking proper operation of the pH meter.

Weigh or measure 5 g of air-dry soil into 28-g (1-oz) paper cups, add 5 ml of distilled water, mix or stir, let stand, insert electrodes, and read soil pH in water or 0.01M  $CaCl_2$  as described in section 12-2.6.5 under procedure for soil pH. Add 10 ml of the buffer solution to the soil suspensions after pH values in water or 0.01M  $CaCl_2$  are read.

Place the tray in a mechanical shaker,<sup>6</sup> close the cover tightly, and shake at 250 oscillations/min for 10 min. Open the lid of the shaker, and let the suspensions stand 30 min before determining the pH. An alternate

<sup>5</sup> Although less tedious procedures may be used for preparing small quantities of the buffer solution, the following procedure has been found to be most satisfactory for preparing bulk quantities of the buffer solution.

<sup>6</sup> Top of shaker is fitted with rubber sheet stretched over rubber foam, so that when the top is closed and fastened, the cups are rendered essentially airtight. When shaking is completed, a few swipes with a clean sponge cleans the rubber sheet.

#### 12-3 LIME REQUIREMENT

choice is 15 min of shaking read (McLean, 1965). The importance, but the frequency oscillations/min, may have

Stir the soil suspension terminating soil pH. Read the soil-buffer pH.

Select and record the pH you choose to lime the

If plowing depth differs proportion to the proportion pure  $CaCO_3$  required, difference in case one wishes to use

**12-3.4.4.5 Comment.** particularly high in LR and recognized that the SMP may very low LR. However, include the following section improve

Table 12-1. Calibrations to determine Ag-Ground lime

| Soil-buffer pH | Amend         |
|----------------|---------------|
|                | Pure $CaCO_3$ |
| 6.8            | 2.0           |
| 6.7            | 4.1           |
| 6.6            | 5.3           |
| 6.5            | 7.0           |
| 6.4            | 9.0           |
| 6.3            | 10.5          |
| 6.2            | 12.1          |
| 6.1            | 13.4          |
| 6.0            | 15.2          |
| 5.9            | 17.2          |
| 5.8            | 18.6          |
| 5.7            | 20.1          |
| 5.6            | 21.8          |
| 5.5            | 23.3          |
| 5.4            | 25.3          |
| 5.3            | 26.7          |
| 5.2            | 28.5          |
| 5.1            | 30.2          |
| 5.0            | 31.8          |
| 4.9            | 33.6          |
| 4.8            | 34.9          |

† Ag-Ground lime of 90%, plus less of 40% < 100-mesh, 50%

in section 12-2.6.4.

) buffer solution (preparation de-

fer.<sup>5</sup>

0 g.

•2H<sub>2</sub>O), 955.8 g.

d water. Shake vigorously as you  
g for a few minutes to prevent

OAc)<sub>2</sub> into a separate container,  
of distilled water.

2, shaking as they are combined.  
irs.

, again shaking as the addition is

completely dissolved. This takes

dioxide (NaOH) using the stand-

ct.

cy of drierite, 2.5 by 30 cm  
1 cylinder of drierite in series to  
2 and water vapor.

he pH meter as described previ-  
ffer is adjusted to pH 7.5 and is  
, its pH changes very little from  
econdary standard for checking

28-g (1-oz) paper cups, add 5 ml  
rt electrodes, and read soil pH in  
on 12-2.6.5 under procedure for  
to the soil suspensions after pH

r,<sup>6</sup> close the cover tightly, and  
pen the lid of the shaker, and let  
rmining the pH. An alternate

preparing small quantities of the buffer  
e most satisfactory for preparing bulk

ver rubber foam, so that when the top is  
airtight. When shaking is completed, a

choice is 15 min of shaking and 15 min of standing time before the pH is read (McLean, 1975). The times of shaking and standing are of prime importance, but the intensity of the shaking, such as at 250 to as low as 200 oscillations/min, may have little effect on the soil-buffer pH reading.

Stir the soil suspension by swirling the electrodes as described for determining soil pH. Read the pH on the standardized pH meter. Record as soil-buffer pH.

Select and record the amount of lime required to bring the soil to the pH you choose to lime the soil, based on the soil-buffer pH of Table 12-1.

If plowing depth differs from 20 cm, increase or decrease the LR in proportion to the deviation in plowing depth from 20 cm. The amounts of pure CaCO<sub>3</sub> required to bring the soil to pH 7.0 are given as points of reference in case one wishes to use another grade of lime than Ag-Ground lime.

12-3.4.4.5 **Comments.** The SMP method is designed for soils that are particularly high in LR and that have considerable exchangeable Al. It is recognized that the SMP method is not very accurate when used on soils of very low LR. However, inclusion of the double-buffer feature described in the following section improves the accuracy considerably for low LR soils.

Table 12-1. Calibrations to determine lime requirement of the surface 20 cm of soil using the SMP single-buffer method.

| Soil-buffer<br>pH | Desired pH  |                      |               |      |      |
|-------------------|---|----------------------|---------------|------|------|
|                   | 7.0   | 7.0                  | 6.5           | 6.0  | 5.2  |
|                   | Amendment required to reach desired pH (metric tons/ha) |                      |               |      |      |
|                   | Mineral soils   |                      | Organic soils |      |      |
|                   | Pure<br>CaCO <sub>3</sub>                               | Ag-Ground limestone† |               |      |      |
| 6.8               | 2.4   | 3.2                  | 2.7           | 2.3  | 1.5  |
| 6.7               | 4.1   | 5.3                  | 4.7           | 3.8  | 2.9  |
| 6.6               | 5.3   | 7.6                  | 6.5           | 5.3  | 4.0  |
| 6.5               | 7.0   | 10.1                 | 8.5           | 7.0  | 5.3  |
| 6.4               | 9.0   | 12.3                 | 10.5          | 8.5  | 6.5  |
| 6.3               | 10.5  | 14.6                 | 12.3          | 10.1 | 7.8  |
| 6.2               | 12.1  | 16.8                 | 14.3          | 11.6 | 9.0  |
| 6.1               | 13.4  | 19.2                 | 16.1          | 13.2 | 10.3 |
| 6.0               | 15.2  | 21.5                 | 18.1          | 14.8 | 11.4 |
| 5.9               | 17.2  | 23.8                 | 20.1          | 16.3 | 12.8 |
| 5.8               | 18.6  | 26.2                 | 21.9          | 17.9 | 13.9 |
| 5.7               | 20.1  | 28.5                 | 23.9          | 19.5 | 15.0 |
| 5.6               | 21.8  | 30.6                 | 26.0          | 21.0 | 16.3 |
| 5.5               | 23.3  | 33.2                 | 28.0          | 22.8 | 17.5 |
| 5.4               | 25.3  | 35.4                 | 30.0          | 24.4 | 18.8 |
| 5.3               | 26.7  | 37.8                 | 31.8          | 26.0 | 19.9 |
| 5.2               | 28.5  | 40.1                 | 33.8          | 27.6 | 21.0 |
| 5.1               | 30.2  | 42.5                 | 35.8          | 29.1 | 22.4 |
| 5.0               | 31.8  | 44.8                 | 37.8          | 30.6 | 23.5 |
| 4.9               | 33.6  | 47.2                 | 39.9          | 32.3 | 24.7 |
| 4.8               | 34.9  | 49.5                 | 41.6          | 33.8 | 26.0 |

† Ag-Ground lime of 90%, plus total neutralizing power or CaCO<sub>3</sub> equivalent, and fineness of 40% < 100-mesh, 50% < 60-mesh, 70% < 20-mesh, and 95% < 8-mesh.





**PARTICLE SIZE DISTRIBUTION**

**METHOD D421**

**AMERICAN SOCIETY FOR TESTING AND MATERIALS  
(ASTM, 1985)**





## Standard Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants<sup>1</sup>

This standard is issued under the fixed designation D 421; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This practice covers the dry preparation of soil samples as received from the field for particle-size analysis and the determination of the soil constants.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

### 2. Referenced Documents

#### 2.1 ASTM Standards:

D 2217 Practice for Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants<sup>2</sup>

E 11 Specification for Wire-Cloth Sieves for Testing Purposes<sup>3</sup>

### 3. Significance and Use

3.1 This practice can be used to prepare samples for particle-size and plasticity tests where it is desired to determine test values on air-dried samples, or where it is known that air drying does not have an effect on test results relative to samples prepared in accordance with Practice D 2217.

### 4. Apparatus

4.1 *Balance*, sensitive to 0.1 g.

4.2 *Mortar and Rubber-Covered Pestle*, suitable for breaking up the aggregations of soil particles.

4.3 *Sieves*—A series of sieves, of square mesh woven wire cloth, conforming to Specification E 11. The sieves required are as follows:

No. 4 (4.75-mm)  
No. 10 (2.00-mm)  
No. 40 (425- $\mu$ m)

4.4 *Sampler*—A riffle sampler or sample splitter, for quartering the samples.

### 5. Sampling

5.1 Expose the soil sample as received from the field to the

air at room temperature until dried thoroughly. Break up the aggregations thoroughly in the mortar with a rubber-covered pestle. Select a representative sample of the amount required to perform the desired tests by the method of quartering or by the use of a sampler. The amounts of material required to perform the individual tests are as follows:

5.1.1 *Particle-Size Analysis*—For the particle-size analysis, material passing a No. 10 (2.00-mm) sieve is required in amounts equal to 115 g of sandy soils and 65 g of either silt or clay soils.

5.1.2 *Tests for Soil Constants*—For the tests for soil constants, material passing the No. 40 (425- $\mu$ m) sieve is required in total amount of 220 g, allocated as follows:

| Test                           | Grams |
|--------------------------------|-------|
| Liquid limit                   | 100   |
| Plastic limit                  | 15    |
| Centrifuge moisture equivalent | 10    |
| Volumetric shrinkage           | 30    |
| Check tests                    | 65    |

### 6. Preparation of Test Sample

6.1 Select that portion of the air-dried sample selected for purpose of tests and record the mass as the mass of the total test sample uncorrected for hygroscopic moisture. Separate the test sample by sieving with a No. 10 (2.00-mm) sieve. Grind that fraction retained on the No. 10 sieve in a mortar with a rubber-covered pestle until the aggregations of soil particles are broken up into the separate grains. Then separate the ground soil into two fractions by sieving with a No. 10 sieve.

6.2 Wash that fraction retained after the second sieving, free of all fine material, dry, and weigh. Record this mass as the mass of coarse material. Sieve the coarse material, after being washed and dried, on the No. 4 (4.75-mm) sieve and record the mass retained on the No. 4 sieve.

### 7. Test Sample for Particle-Size Analysis

7.1 Thoroughly mix together the fractions passing the No. 10 (2.00-mm) sieve in both sieving operations, and by the method of quartering or the use of a sampler, select a portion weighing approximately 115 g for sandy soils and approximately 65 g for silt and clay soil for particle-size analysis.

### 8. Test Sample for Soil Constants

8.1 Separate the remaining portion of the material passing the No. 10 (2.00-mm) sieve into two parts by means of a No. 40 (425- $\mu$ m) sieve. Discard the fraction retained on the No. 40 sieve. Use the fraction passing the No. 40 sieve for the determination of the soil constants.

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.03 on Texture, Plasticity, and Density Characteristics of Soils.

Current edition approved July 26, 1985. Published September 1985. Originally published as D 421 - 35 T. Last previous edition D 421 - 58 (1978)<sup>11</sup>.

<sup>2</sup> Annual Book of ASTM Standards, Vol 04.08.

<sup>3</sup> Annual Book of ASTM Standards, Vol 14.02.



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**CATION EXCHANGE CAPACITY**

**METHOD 9081**

**TEST METHODS FOR EVALUATING SOLID WASTE  
PHYSICAL/CHEMICAL METHODS, SW-846 (EPA, 1984)**



## METHOD 9081

### CATION-EXCHANGE CAPACITY OF SOILS (SODIUM ACETATE)

#### 1.0 SCOPE AND APPLICATION

1.1 Method 9081 is applicable to most soils, including calcareous and noncalcareous soils. The method of cation-exchange capacity by summation (Chapman, 1965, p. 900; see Paragraph 10.1) should be employed for distinctly acid soils.

#### 2.0 SUMMARY OF METHOD

2.1 The soil sample is mixed with an excess of sodium acetate solution, resulting in an exchange of the added sodium cations for the matrix cations. Subsequently, the sample is washed with isopropyl alcohol. An ammonium acetate solution is then added, which replaces the adsorbed sodium with ammonium. The concentration of displaced sodium is then determined by atomic absorption, emission spectroscopy, or an equivalent means.

#### 3.0 INTERFERENCES

3.1 Interferences can occur during analysis of the extract for sodium content. Thoroughly investigate the chosen analytical method for potential interferences.

#### 4.0 APPARATUS AND MATERIALS

4.1 Centrifuge tube and stopper: 50-mL, round-bottom, narrow neck.

4.2 Mechanical shaker.

4.3 Volumetric flask: 100-mL.

#### 5.0 REAGENTS

5.1 Sodium acetate (NaOAc), 1.0 N: Dissolve 136 g of  $\text{NaC}_2\text{H}_3\text{O}_2 \cdot 3\text{H}_2\text{O}$  in water and dilute it to 1,000 mL. The pH of this solution should be 8.2. If needed, add a few drops of acetic acid or NaOH solution to bring the reaction of the solution to pH 8.2.

5.2 Ammonium acetate ( $\text{NH}_4\text{OAc}$ ), 1 N: Dilute 114 mL of glacial acetic acid (99.5%) with water to a volume of approximately 1 liter. Then add 138 mL of concentrated ammonium hydroxide ( $\text{NH}_4\text{OH}$ ) and add water to obtain a volume of about 1,980 mL. Check the pH of the resulting solution, add more  $\text{NH}_4\text{OH}$ , as needed, to obtain a pH of 7, and dilute the solution to a volume of 2 liters with water.



5.3 Isopropyl alcohol: 99%.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 All samples must be collected using a sampling plan that addresses the considerations discussed in Chapter Nine of this manual.

7.0 PROCEDURE

7.1 Weigh 4 g of medium- or fine-textured soil or 6 g of coarse-textured soil and transfer the sample to a 50-mL, round-bottom, narrow-neck centrifuge tube. (A fine soil has >50% of the particles  $\leq 0.074$  mm, medium soil has >50%  $\geq 0.425$  mm, while a coarse soil has more than 50% of its particles  $\geq 2$  mm.)

7.2 Add 33 mL of 1.0 N NaOAc solution, stopper the tube, shake it in a mechanical shaker for 5 min, and centrifuge it until the supernatant liquid is clear.

7.3 Decant the liquid, and repeat Paragraph 7.2 three more times.

7.4 Add 33 mL of 99% isopropyl alcohol, stopper the tube, shake it in a mechanical shaker for 5 min, and centrifuge it until the supernatant liquid is clear.

7.5 Repeat the procedure described in Paragraph 7.4 two more times.

7.6 Add 33 mL of  $\text{NH}_4\text{OAc}$  solution, stopper the tube, shake it in a mechanical shaker for 5 min, and centrifuge it until the supernatant liquid is clear. Decant the washing into a 100-mL volumetric flask.

7.7 Repeat the procedure described in Paragraph 7.6 two more times.

7.8 Dilute the combined washing to the 100-mL mark with ammonium acetate solution and determine the sodium concentration by atomic absorption, emission spectroscopy, or an equivalent method.

8.0 QUALITY CONTROL

8.1 All quality control data should be maintained and available for easy reference or inspection.

8.2 Employ a minimum of one blank per sample batch to determine if contamination or any memory effects are occurring.

8.3 Materials of known cation-exchange capacity must be routinely analyzed.

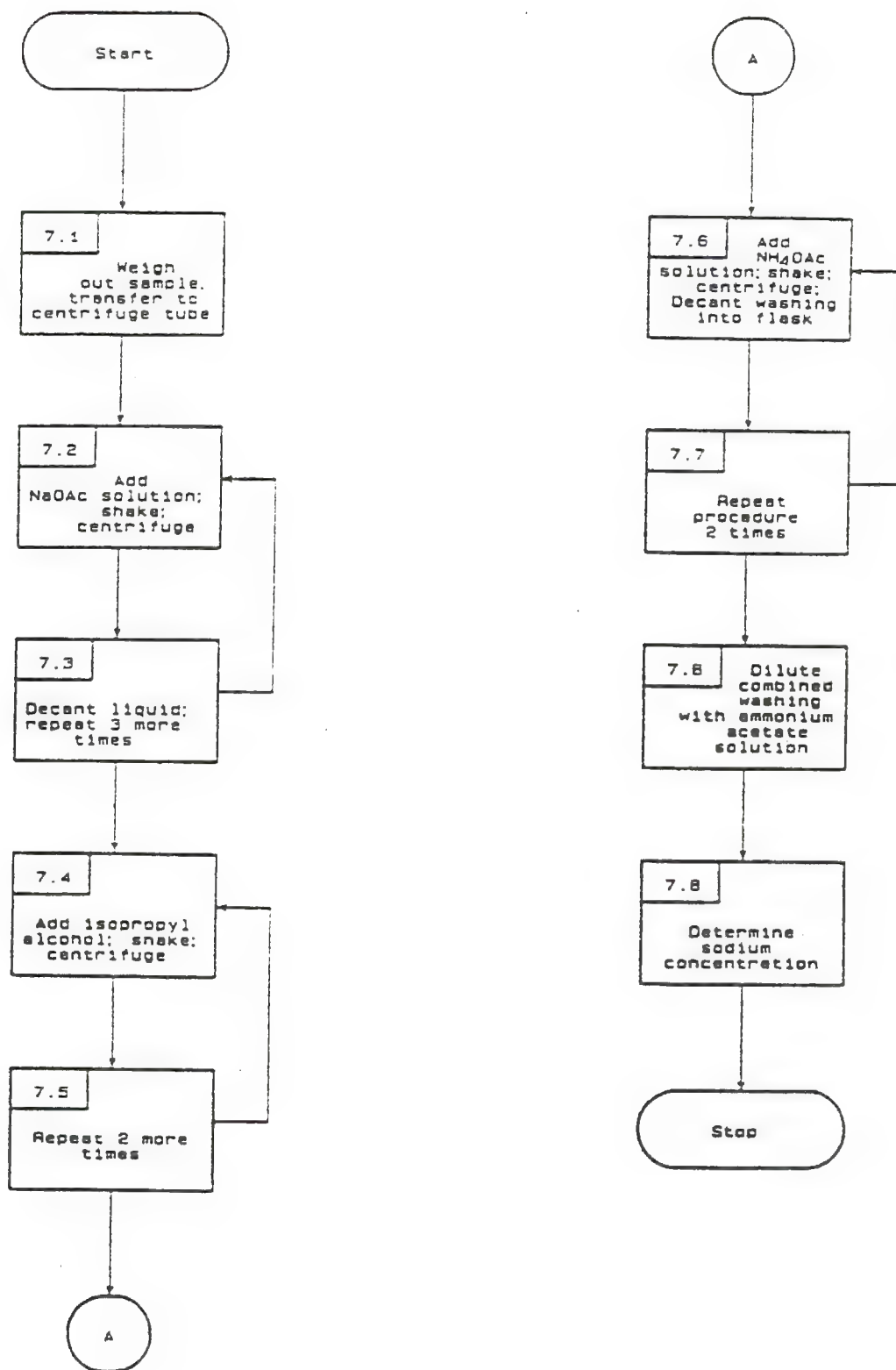
## 9.0 METHOD PERFORMANCE

9.1 No data provided.

## 10.0 REFERENCES

10.1 This method is based on Chapman, H.D., "Cation-exchange Capacity," pp. 891-900, in C.A. Black (ed.), Method of Soil Analysis, Part 2: Chemical and Microbiological Properties, Am. Soc. Agron., Madison, Wisconsin (1965).

METHOD 9081  
CATION-EXCHANGE CAPACITY OF SOILS (SODIUM ACETATE)



**SULFATE**

**METHOD 9038**

**TEST METHODS FOR EVALUATING SOLID WASTE  
PHYSICAL/CHEMICAL METHODS, SW-846 (EPA, 1984)**





SULFATE (TURBIDIMETRIC)

1.0 SCOPE AND APPLICATION

1.1 This method is applicable to ground water, drinking and surface waters, and domestic and industrial wastes.

1.2 This method is suitable for all concentration ranges of sulfate ( $\text{SO}_4^{2-}$ ); however, in order to obtain reliable readings, use a sample aliquot containing not more than 40 mg/L of  $\text{SO}_4^{2-}$ .

1.3 The minimum detectable limit is approximately 1 mg/L of  $\text{SO}_4^{2-}$ .

2.0 SUMMARY OF METHOD

2.1 Sulfate ion is converted to a barium sulfate suspension under controlled conditions. The resulting turbidity is determined by a nephelometer, filter photometer, or spectrophotometer and compared with a curve prepared from standard sulfate solution.

3.0 INTERFERENCES

3.1 Color and turbidity due to the sample matrix can cause positive interferences which must be accounted for by use of blanks.

3.2 Silica in concentrations over 500 mg/L will interfere.

4.0 APPARATUS AND MATERIALS

4.1 Magnetic stirrer: Variable speed so that it can be held constant just below splashing. Use identical shapes and sizes of magnetic stirring bars.

4.2 Photometer (one of the following, given in order of preference):

4.2.1 Nephelometer.

4.2.2 Spectrophotometer: For use at 420 nm with light path of 4 to 5 cm.

4.2.3 Filter photometer: With a violet filter having a maximum near 420 nm and a light path of 4 to 5 cm.

4.3 Stopwatch: If the magnetic stirrer is not equipped with an accurate timer.

4.4 Measuring spoon: Capacity 0.2 to 0.3 mL.

## 5.0 REAGENTS

5.1 ASTM Type II water (ASTM D1193): Water should be monitored for impurities.

5.2 Conditioning reagent: Slowly add 30 mL concentrated HCl to 300 mL Type II water, 100 mL 95% ethanol or isopropanol, and 75 g NaCl in solution in a container. Add 50 mL glycerol and mix.

5.3 Barium chloride ( $\text{BaCl}_2$ ): Crystals, 20 to 30 mesh.

5.4 Sodium carbonate solution: (approximately 0.05 N): Dry 3 to 5 g primary standard  $\text{Na}_2\text{CO}_3$  at  $250^\circ\text{C}$  for 4 hr and cool in a desiccator. Weigh  $2.5 \pm 0.2$  g (to the nearest mg), transfer to a 1-liter volumetric flask, and fill to the mark with Type II water.

5.5 Proprietary reagents: Such as Hach Sulfaver or equivalent, are acceptable.

5.6 Standard sulfate solution ( $1.00 \text{ mL} = 100 \text{ ug SO}_4^{2-}$ ): Prepare by Paragraph 5.6.1 or 5.6.2.

### 5.6.1 Standard sulfate solution from $\text{H}_2\text{SO}_4$ :

5.6.1.1 Standard sulfuric acid, 0.1 N: Dilute 3.0 mL concentrated  $\text{H}_2\text{SO}_4$  to 1 liter with Type II water. Standardize against 40.0 mL of 0.05 N  $\text{Na}_2\text{CO}_3$  solution (Paragraph 5.4) with about 60 mL Type II water by titrating potentiometrically to a pH of about 5. Lift electrodes and rinse into beaker. Boil gently for 3 to 5 min under a watch glass cover. Cool to room temperature. Rinse cover glass into beaker. Continue titration to the pH inflection point. Calculate the normality of  $\text{H}_2\text{SO}_4$  using:

$$N = \frac{A \times B}{53.00 \times C}$$

where:

A = g  $\text{Na}_2\text{CO}_3$  weighed into 1 liter flask (Paragraph 5.4);

B = mL  $\text{Na}_2\text{CO}_3$  solution used in the standardization;

C = mL acid used in titration;

5.6.1.2 Standard acid, 0.02 N: Dilute appropriate amount of standard acid, 0.1 N (Paragraph 5.6.1.1) to 1 liter (use 200.00 mL standard acid if normality is 0.1000 N). Check by standardization against 15 mL of 0.05 N  $\text{Na}_2\text{CO}_3$  solution (Paragraph 5.4).

5.6.1.3 Place 10 mL standard sulfuric acid, 0.02 N (Paragraph 5.6.1.2) in a 100-mL volumetric flask and dilute to the mark.

5.6.2 Standard sulfate solution from  $\text{Na}_2\text{SO}_4$ : Dissolve 147.9 mg anhydrous  $\text{Na}_2\text{SO}_4$  in Type II water in a 1-liter volumetric flask and dilute to the mark with Type II water.

## 6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 All samples must have been collected using a sampling plan that addresses the considerations discussed in Chapter Nine of this manual.

6.2 Preserve by refrigerating at 4°C.

## 7.0 PROCEDURE

### 7.1 Formation of barium sulfate turbidity:

7.1.1 Place a 100-mL sample, or a suitable portion diluted to 100 mL, into a 250-mL Erlenmeyer flask.

7.1.2 Add exactly 5.0 mL conditioning reagent (Paragraph 5.2).

7.1.3 Mix in the stirring apparatus.

7.1.4 While the solution is being stirred, add a measured spoonful of  $\text{BaCl}_2$  crystals (Paragraph 5.3) and begin timing immediately.

7.1.5 Stir exactly 1.0 min at constant speed.

### 7.2 Measurement of barium sulfate turbidity:

7.2.1 Immediately after the stirring period has ended, pour solution into absorbance cell.

7.2.2 Measure turbidity at 30-sec intervals for 4 min.

7.2.3 Record the maximum reading obtained in the 4-min period.

### 7.3 Preparation of calibration curve:

7.3.1 Prepare calibration curve using standard sulfate solution (Paragraph 5.6).

7.3.2 Space standards at 5-mg/L increments in the 0-40 mg/L sulfate range.

7.3.3 Above 50 mg/L the accuracy decreases and the suspensions lose stability.



7.3.4 Check reliability of calibration curve by running a standard with every three or four samples.

#### 7.4 Correction for sample color and turbidity:

7.4.1 Run a sample blank using steps 7.1 and 7.2, without the addition of barium chloride (Paragraph 7.1.4).

#### 7.5 Calculation:

7.5.1 Read  $\text{mg SO}_4^{-2}$  from linear calibration curve:

$$\text{mg SO}_4^{-2}/\text{L} = \frac{\text{mg SO}_4^{-2} \times 1,000}{\text{mL sample}}$$

### 8.0 QUALITY CONTROL

8.1 All quality control data should be maintained and available for easy reference or inspection.

8.2 Calibration curves must be composed of a minimum of a blank and three standards. A calibration curve should be made for every hour of continuous sample analysis.

8.3 Dilute samples if they are more concentrated than the highest standard or if they fall on the plateau of a calibration curve.

8.4 Employ a minimum of one blank per sample batch to determine if contamination has occurred.

8.5 Verify calibration with an independently prepared check standard every 15 samples.

8.6 Run one spike duplicate sample for every 10 samples. A spike duplicate sample is a sample brought through the whole sample preparation and analytical process.

### 9.0 METHOD PERFORMANCE

9.1 Thirty-four analysts in 16 laboratories analyzed six synthetic water samples containing exact increments of inorganic sulfate with the following results:

| Increment as<br>Sulfate<br>(mg/L) | Precision as<br>Standard Deviation<br>(mg/L) | Accuracy as |                |
|-----------------------------------|--|-------------|----------------|
|                                   |  | Bias<br>(%) | Bias<br>(mg/L) |
| 8.6                               | 2.30   | -3.72       | -0.3           |
| 9.2                               | 1.78   | -8.26       | -0.8           |
| 110                               | 7.86   | -3.01       | -3.3           |
| 122                               | 7.50   | -3.37       | -4.1           |
| 188                               | 9.58   | +0.04       | +0.1           |
| 199                               | 11.8   | -1.70       | -3.4           |

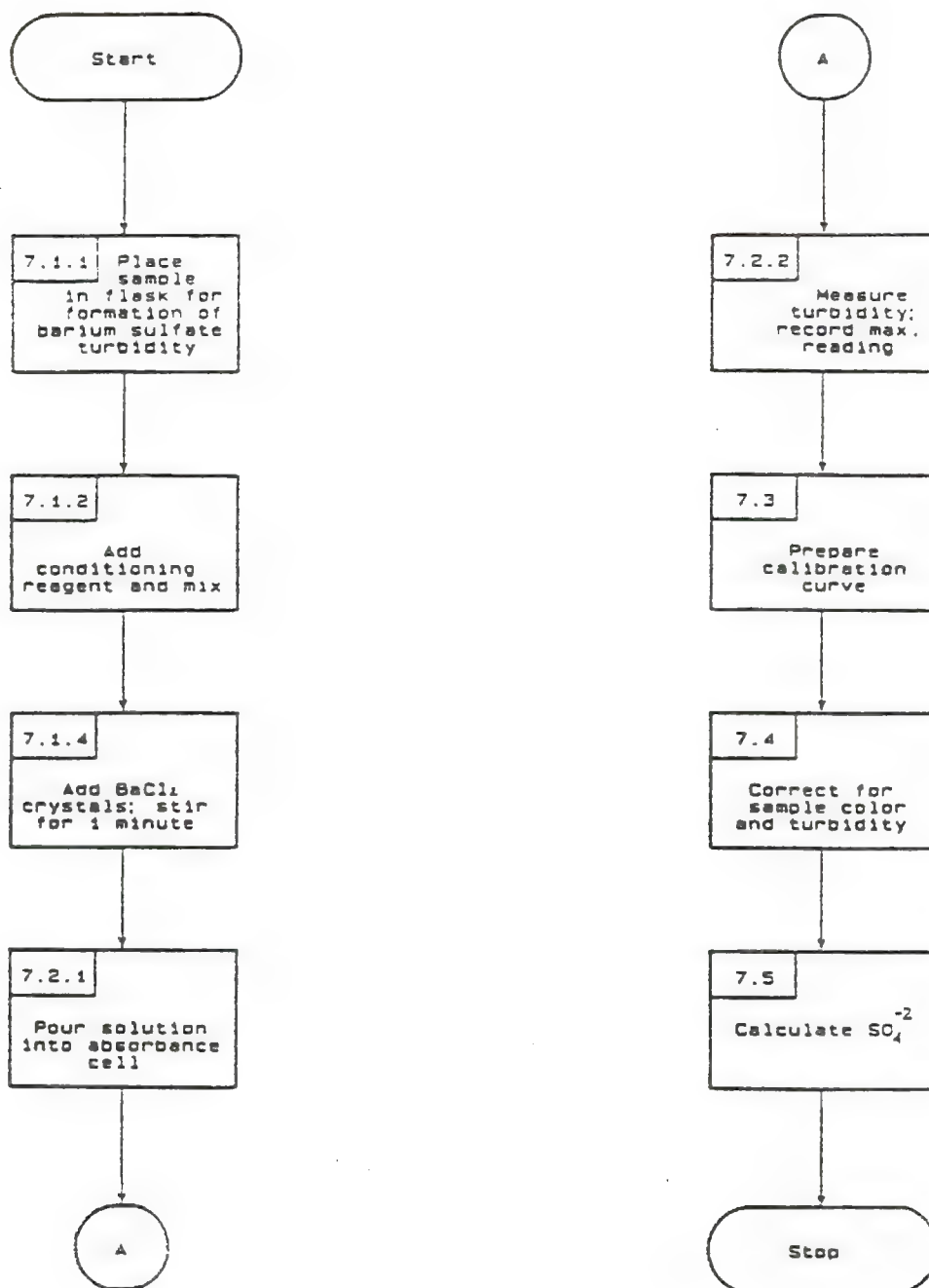
(Data from: FWPCA Method Study 1, Mineral and Physical Analyses.)

9.2 A synthetic unknown sample containing 259 mg/L sulfate, 108 mg/L Ca, 82 mg/L Mg, 3.1 mg/L K, 19.9 mg/L Na, 241 mg/L chloride, 0.250 mg/L nitrite N, 1.1 mg/L nitrate N, and 42.5 mg/L total alkalinity (contributed by  $\text{NaHCO}_3$ ), was analyzed in 19 laboratories by the turbidimetric method, with a relative standard deviation of 9.1% and a relative error of 1.2%.

#### 10.0 REFERENCES

1. Annual Book of ASTM Standards, Part 31, "Water," Standard D516-68, Method B, p. 430 (1976).
2. Standard Methods for the Examination of Water and Wastewater, 14th ed., p. 496, Method 427C, (1975).

METHOD 9038  
SULFATE (TURBIDIMETRIC)



**NITRATE/NITRITE**

**METHOD 353.2**

**METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES  
(EPA, 1984)**





# NITROGEN, NITRATE-NITRITE

Method 353.2 (Colorimetric, Automated, Cadmium Reduction)

STORET NO. Total 00630

## 1. Scope and Application

- 1.1 This method pertains to the determination of nitrite singly, or nitrite and nitrate combined in surface and saline waters, and domestic and industrial wastes. The applicable range of this method is 0.05 to 10.0 mg/1 nitrate-nitrite nitrogen. The range may be extended with sample dilution.

## 2. Summary of Method

- 2.1 A filtered sample is passed through a column containing granulated copper-cadmium to reduce nitrate to nitrite. The nitrite (that originally present plus reduced nitrate) is determined by diazotizing with sulfanilamide and coupling with N-(1-naphthyl)-ethylenediamine dihydrochloride to form a highly colored azo dye which is measured colorimetrically. Separate, rather than combined nitrate-nitrite, values are readily obtained by carrying out the procedure first with, and then without, the Cu-Cd reduction step.

## 3. Sample Handling and Preservation

- 3.1 Analysis should be made as soon as possible. If analysis can be made within 24 hours, the sample should be preserved by refrigeration at 4°C. When samples must be stored for more than 24 hours, they should be preserved with sulfuric acid (2 ml conc. H<sub>2</sub>SO<sub>4</sub> per liter) and refrigeration.

Caution: Samples for reduction column must not be preserved with mercuric chloride.

## 4. Interferences

- 4.1 Build up of suspended matter in the reduction column will restrict sample flow. Since nitrate-nitrogen is found in a soluble state, the sample may be pre-filtered.
- 4.2 Low results might be obtained for samples that contain high concentrations of iron, copper or other metals. EDTA is added to the samples to eliminate this interference.
- 4.3 Samples that contain large concentrations of oil and grease will coat the surface of the cadmium. This interference is eliminated by pre-extracting the sample with an organic solvent.

## 5. Apparatus

- 5.1 Technicon AutoAnalyzer (AAI or AAI) consisting of the following components:
  - 5.1.1 Sampler.
  - 5.1.2 Manifold (AAI) or analytical cartridge (AAII).
  - 5.1.3 Proportioning Pump
  - 5.1.4 Colorimeter equipped with a 15 mm or 50 mm tubular flow cell and 540 nm filters.
  - 5.1.5 Recorder.

Approved for NPDES and SDWA

Issued 1971

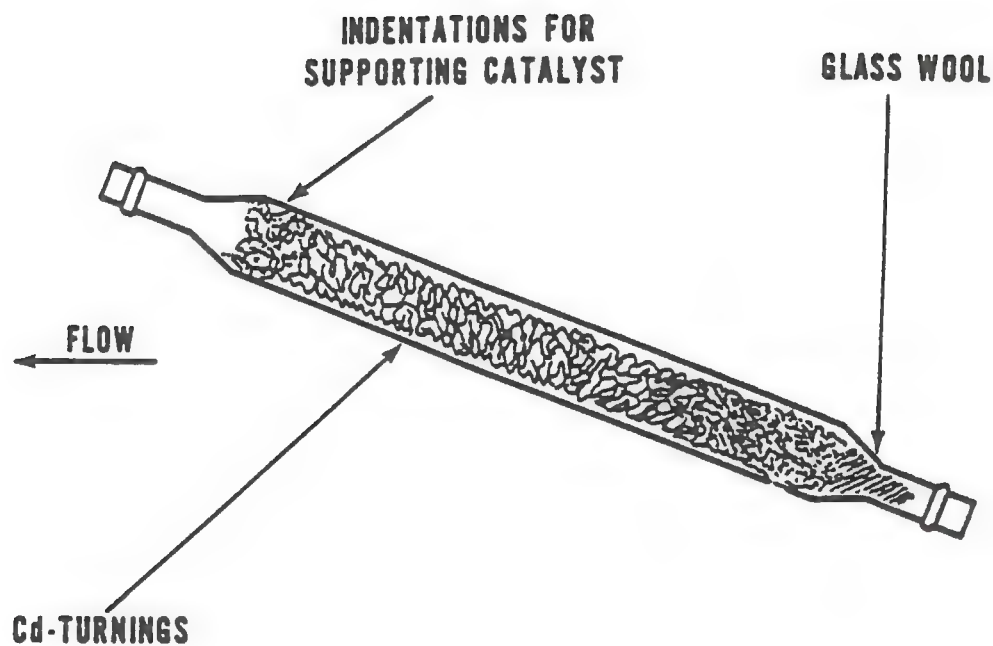
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5.1.6 Digital printer for AAI (Optional).

6. Reagents

- 6.1 Granulated cadmium: 40-60 mesh (MCB Reagents).
- 6.2 Copper-cadmium: The cadmium granules (new or used) are cleaned with dilute HCl (6.7) and copperized with 2% solution of copper sulfate (6.8) in the following manner:
  - 6.2.1 Wash the cadmium with HCl (6.7) and rinse with distilled water. The color of the cadmium so treated should be silver.
  - 6.2.2 Swirl 10 g cadmium in 100 ml portions of 2% solution of copper sulfate (6.8) for five minutes or until blue color partially fades, decant and repeat with fresh copper sulfate until a brown colloidal precipitate forms.
  - 6.2.3 Wash the cadmium-copper with distilled water (at least 10 times) to remove all the precipitated copper. The color of the cadmium so treated should be black.
- 6.3 Preparation of reduction column AAI: The reduction column is an 8 by 50 mm glass tube with the ends reduced in diameter to permit insertion into the system. Copper-cadmium granules (6.2) are placed in the column between glass wool plugs. The packed reduction column is placed in an up-flow 20° incline to minimize channeling. See Figure 1.
- 6.4 Preparation of reduction column AAI: The reduction column is a U-shaped, 35 cm length, 2 mm I.D. glass tube (Note 1). Fill the reduction column with distilled water to prevent entrapment of air bubbles during the filling operations. Transfer the copper-cadmium granules (6.2) to the reduction column and place a glass wool plug in each end. To prevent entrapment of air bubbles in the reduction column be sure that all pump tubes are filled with reagents before putting the column into the analytical system.

NOTE 1: A 0.081 I.D. pump tube (purple) can be used in place of the 2 mm glass tube.
- 6.5 Distilled water: Because of possible contamination, this should be prepared by passage through an ion exchange column comprised of a mixture of both strongly acidic-cation and strongly basic-anion exchange resins. The regeneration of the ion exchange column should be carried out according to the manufacturer's instructions.
- 6.6 Color reagent: To approximately 800 ml of distilled water, add, while stirring, 100-ml conc. phosphoric acid, 40 g sulfanilamide, and 2 g N-1-naphthylethylenediamine dihydrochloride. Stir until dissolved and dilute to 1 liter. Store in brown bottle and keep in the dark when not in use. This solution is stable for several months.
- 6.7 Dilute hydrochloric acid, 6N: Dilute 50 ml of conc. HCl to 100 ml with distilled water.
- 6.8 Copper sulfate solution, 2%: Dissolve 20 g of  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  in 500 ml of distilled water and dilute to 1 liter.
- 6.9 Wash solution: Use distilled water for unpreserved samples. For samples preserved with  $\text{H}_2\text{SO}_4$ , use 2 ml  $\text{H}_2\text{SO}_4$  per liter of wash water.
- 6.10 Ammonium chloride-EDTA solution: Dissolve 85 g of reagent grade ammonium chloride and 0.1 g of disodium ethylenediamine tetracetate in 900 ml of distilled water. Adjust the pH to 8.5 with conc. ammonium hydroxide and dilute to 1 liter. Add 1/2 ml Brij-35 (available from Technicon Corporation).



TILT COLUMN TO 20° POSTION

FIGURE 1. COPPER CADMIUM REDUCTION COLUMN  
(1 1/2 ACTUAL SIZE)



- 6.11 Stock nitrate solution: Dissolve 7.218 g  $\text{KNO}_3$  and dilute to 1 liter in a volumetric flask with distilled water. Preserve with 2 ml of chloroform per liter. Solution is stable for 6 months. 1 ml = 1.0 mg  $\text{NO}_3\text{-N}$ .
- 6.12 Stock nitrite solution: Dissolve 6.072 g  $\text{KNO}_2$  in 500 ml of distilled water and dilute to 1 liter in a volumetric flask. Preserve with 2 ml of chloroform and keep under refrigeration. 1.0 ml = 1.0 mg  $\text{NO}_2\text{-N}$ .
- 6.13 Standard nitrate solution: Dilute 10.0 ml of stock nitrate solution (6.11) to 1000 ml. 1.0 ml = 0.01 mg  $\text{NO}_3\text{-N}$ . Preserve with 2 ml of chloroform per liter. Solution is stable for 6 months.
- 6.14 Standard nitrite solution: Dilute 10.0 ml of stock nitrite (6.12) solution to 1000 ml. 1.0 ml = 0.01 mg  $\text{NO}_2\text{-N}$ . Solution is unstable; prepare as required.
- 6.15 Using standard nitrate solution (6.13), prepare the following standards in 100.0 ml volumetric flasks. At least one nitrite standard should be compared to a nitrate standard at the same concentration to verify the efficiency of the reduction column.

| <u>Conc., mg<math>\text{NO}_2\text{-N}</math> or <math>\text{NO}_3\text{-N/l}</math></u> | <u>ml Standard Solution/100 ml</u> |
|--|------------------------------------|
| 0.0  | 0                                  |
| 0.05   | 0.5                                |
| 0.10   | 1.0                                |
| 0.20   | 2.0                                |
| 0.50   | 5.0                                |
| 1.00   | 10.0                               |
| 2.00   | 20.0                               |
| 4.00   | 40.0                               |
| 6.00   | 60.0                               |

NOTE 2: When the samples to be analyzed are saline waters, Substitute Ocean Water (SOW) should be used for preparing the standards; otherwise, distilled water is used. A tabulation of SOW composition follows:

|                              |   |  |
|------------------------------|---|--|
| NaCl - 24.53 g/l             | MgCl <sub>2</sub> - 5.20 g/l              | Na <sub>2</sub> SO <sub>4</sub> - 4.09 g/l |
| CaCl <sub>2</sub> - 1.16 g/l | KCl - 0.70 g/l                            | NaHCO <sub>3</sub> - 0.20 g/l              |
| KBr - 0.10 g/l               | H <sub>3</sub> BO <sub>3</sub> - 0.03 g/l | SrCl <sub>2</sub> - 0.03 g/l               |
| NaF - 0.003 g/l              |   |  |

## 7. Procedure

- 7.1 If the pH of the sample is below 5 or above 9, adjust to between 5 and 9 with either conc. HCl or conc.  $\text{NH}_4\text{OH}$ .
- 7.2 Set up the manifold as shown in Figure 2 (AAI) or Figure 3 (AAII). Note that reductant column should be in 20° incline position (AAI). Care should be taken not to introduce air into reduction column on the AAI.
- 7.3 Allow both colorimeter and recorder to warm up for 30 minutes. Obtain a stable baseline with all reagents, feeding distilled water through the sample line.

NOTE 3: Condition column by running 1 mg/l standard for 10 minutes if a new reduction column is being used. Subsequently wash the column with reagents for 20 minutes.

- 7.4 Place appropriate nitrate and/or nitrite standards in sampler in order of decreasing concentration of nitrogen. Complete loading of sampler tray with unknown samples.
- 7.5 For the AAI system, sample at a rate of 30/hr, 1:1. For the AAI, use a 40/hr, 4:1 cam and a common wash.
- 7.6 Switch sample line to sampler and start analysis.
8. Calculations
  - 8.1 Prepare appropriate standard curve or curves derived from processing NO<sub>2</sub> and/or NO<sub>3</sub> standards through manifold. Compute concentration of samples by comparing sample peak heights with standard curve.
9. Precision and Accuracy
  - 9.1 Three laboratories participating in an EPA Method Study, analyzed four natural water samples containing exact increments of inorganic nitrate, with the following results:

| Increment as<br>Nitrate Nitrogen<br>mg N/liter | Precision as<br>Standard Deviation<br>mg N/liter | Accuracy as |                     |
|--|--|-------------|---------------------|
|  |  | Bias,<br>%  | Bias,<br>mg N/liter |
| 0.29   | 0.012  | + 5.75      | +0.017              |
| 0.35   | 0.092  | +18.10      | +0.063              |
| 2.31   | 0.318  | + 4.47      | +0.103              |
| 2.48   | 0.176  | - 2.69      | -0.067              |

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1. Fiore, J., and O'Brien, J. E., "Automation in Sanitary Chemistry - parts 1 & 2 Determination of Nitrates and Nitrites", *Wastes Engineering* 33, 128 & 238 (1962).
2. Armstrong, F. A., Stearns, C. R., and Strickland, J. D., "The Measurement of Upwelling and Subsequent Biological Processes by Means of the Technicon AutoAnalyzer and Associated Equipment", *Deep Sea Research* 14, p 381-389 (1967).
3. *Annual Book of ASTM Standards*, Part 31, "Water", Standard D1254, p 366 (1976).
4. *Chemical Analyses for Water Quality Manual*, Department of the Interior, FWPCA, R. A. Taft Sanitary Engineering Center Training Program, Cincinnati, Ohio 45226 (January, 1966).
5. *Annual Book of ASTM Standards*, Part 31, "Water", Standard D 1141-75, Substitute Ocean Water, p 48 (1976).

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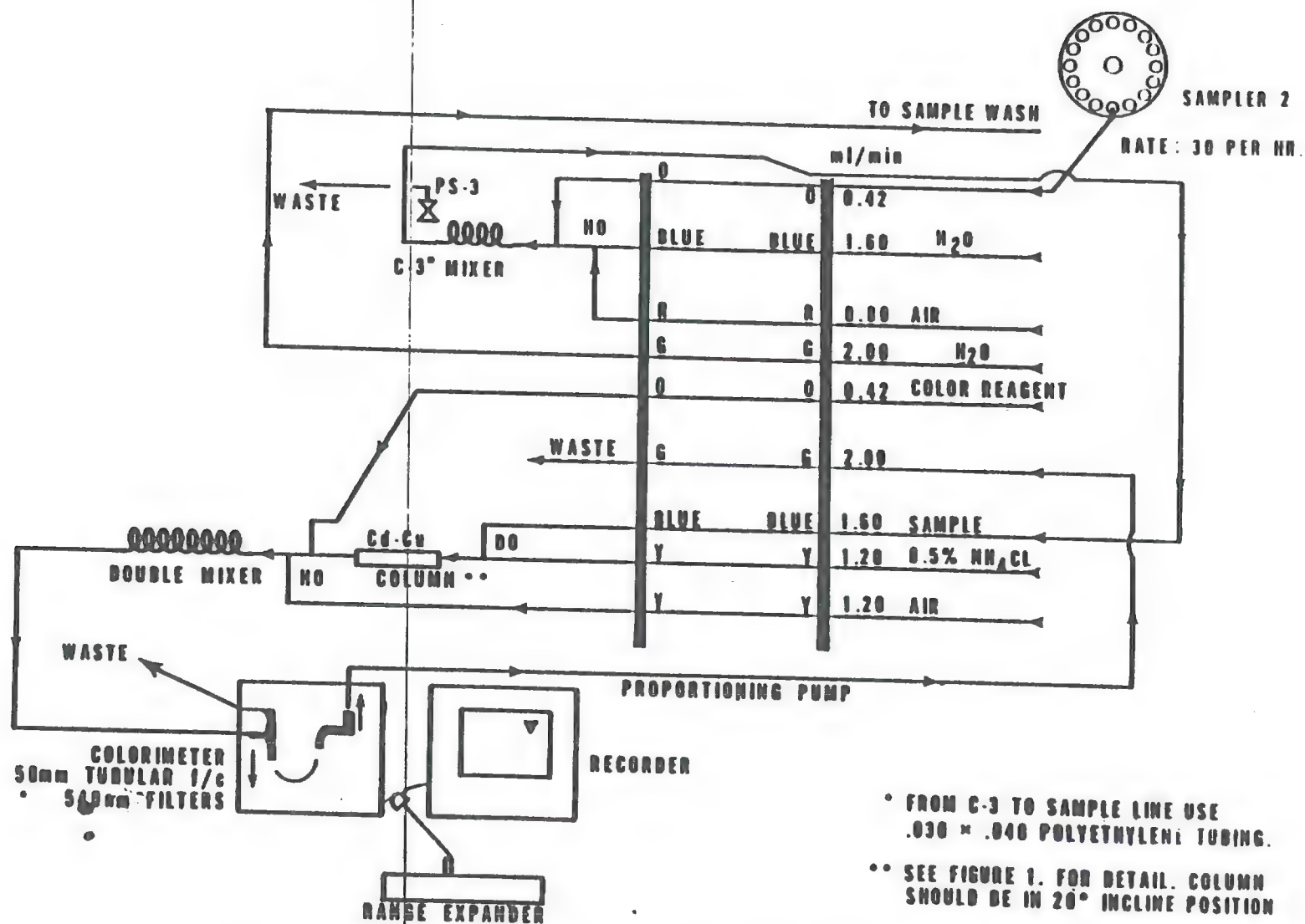


FIGURE 2. NITRATE - NITRITE MANIFOLD AA-1

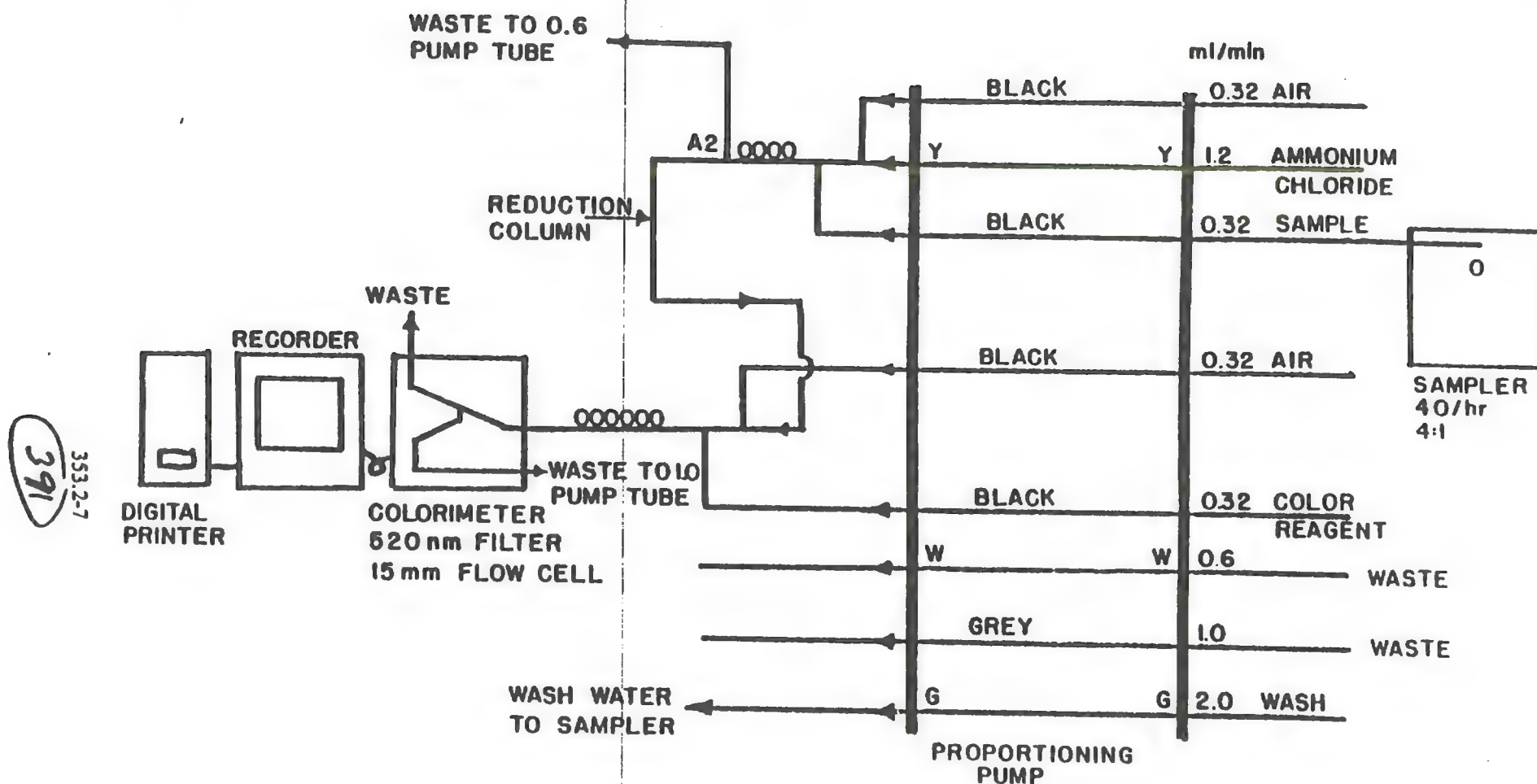


FIGURE 3 NITRATE-NITRITE MANIFOLD AA II





**CHLORIDE**

**METHOD 325.1 OR 325.3**

**METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES  
(EPA, 1984)**



## CHLORIDE

### Method 325.1 (Colorimetric, Automated Ferricyanide AAI)

STORET NO. 00940

1. Scope and Application
  - 1.1 This automated method is applicable to drinking, surface, and saline waters, domestic and industrial wastes. The applicable range is 1 to 250 mg Cl/l. Approximately 15 samples per hour can be analyzed.
2. Summary of Method
  - 2.1 Thiocyanate ion (SCN) is liberated from mercuric thiocyanate through sequestration of mercury by chloride ion to form un-ionized mercuric chloride. In the presence of ferric ion, the liberated SCN forms highly colored ferric thiocyanate in concentration proportional to the original chloride concentration.
3. Sample Handling and Preservation
  - 3.1 No special requirements.
4. Interferences
  - 4.1 No significant interferences.
5. Apparatus
  - 5.1 Technicon AutoAnalyzer consisting of:
    - 5.1.1 Sampler I.
    - 5.1.2 Continuous filter.
    - 5.1.3 Manifold.
    - 5.1.4 Proportioning pump.
    - 5.1.5 Colorimeter equipped with 15 mm tubular flow cell and 480 nm filters.
    - 5.1.6 Recorder.
6. Reagents
  - 6.1 Ferric Ammonium Sulfate: Dissolve 60 g of  $\text{FeNH}_4(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$  in approximately 500 ml distilled water. Add 355 ml of conc.  $\text{HNO}_3$  and dilute to 1 liter with distilled water. Filter.
  - 6.2 Saturated Mercuric Thiocyanate: Dissolve 5 g of  $\text{Hg}(\text{SCN})_2$  in 1 liter of distilled water. Decant and filter a portion of the saturated supernatant liquid to use as the reagent and refill the bottle with distilled water.
  - 6.3 Stock Solution (0.0141 N NaCl): Dissolve 0.8241 g of pre-dried ( $140^\circ\text{C}$ ) NaCl in distilled water. Dilute to 1 liter in a volumetric flask. 1 ml = 0.5 mg Cl.
    - 6.3.1 Prepare a series of standards by diluting suitable volumes of stock solution to 100.0 ml with distilled water. The following dilutions are suggested:

Approved for NPDES  
Issued 1971



| <u>ml of Stock<br/>Solution</u> | <u>Conc., mg/l</u> |
|---------------------------------|--------------------|
| 1.0                             | 5.0                |
| 2.0                             | 10.0               |
| 4.0                             | 20.0               |
| 8.0                             | 40.0               |
| 15.0                            | 75.0               |
| 20.0                            | 100.0              |
| 30.0                            | 150.0              |
| 40.0                            | 200.0              |
| 50.0                            | 250.0              |

## 7. Procedure

- 7.1 No advance sample preparation is required. Set up manifold as shown in Figure 1. For water samples known to be consistently low in chloride content, it is advisable to use only one distilled water intake line.
- 7.2 Allow both colorimeter and recorder to warm up for 30 minutes. Run a baseline with all reagents, feeding distilled water through the sample line. Adjust dark current and operative opening on colorimeter to obtain stable baseline.
- 7.3 Place distilled water wash tubes in alternate openings in sampler and set sample timing at 2.0 minutes.
- 7.4 Place working standards in sampler in order of decreasing concentrations. Complete filling of sampler tray with unknown samples.
- 7.5 Switch sample line from distilled water to sampler and begin analysis.

## 8. Calculation

- 8.1 Prepare standard curve by plotting peak heights of processed standards against known concentrations. Compute concentration of samples by comparing sample peak heights with standard curve.

## 9. Precision and Accuracy

- 9.1 In a single laboratory (EMSL), using surface water samples at concentrations of 1, 100, and 250 mg Cl/l, the standard deviation was  $\pm 0.3$ .
- 9.2 In a single laboratory (EMSL), using surface water samples at concentrations of 10 and 100 mg Cl/l, recoveries were 97% and 104%, respectively.

## Bibliography

1. J. E. O'Brien, "Automatic Analysis of Chlorides in Sewage", Waste Engr., 33, 670-672 (Dec. 1962).
2. Standard Methods for the Examination of Water and Wastewater, 14th Edition, p 613, Method 602 (1975).

273

325.1-3

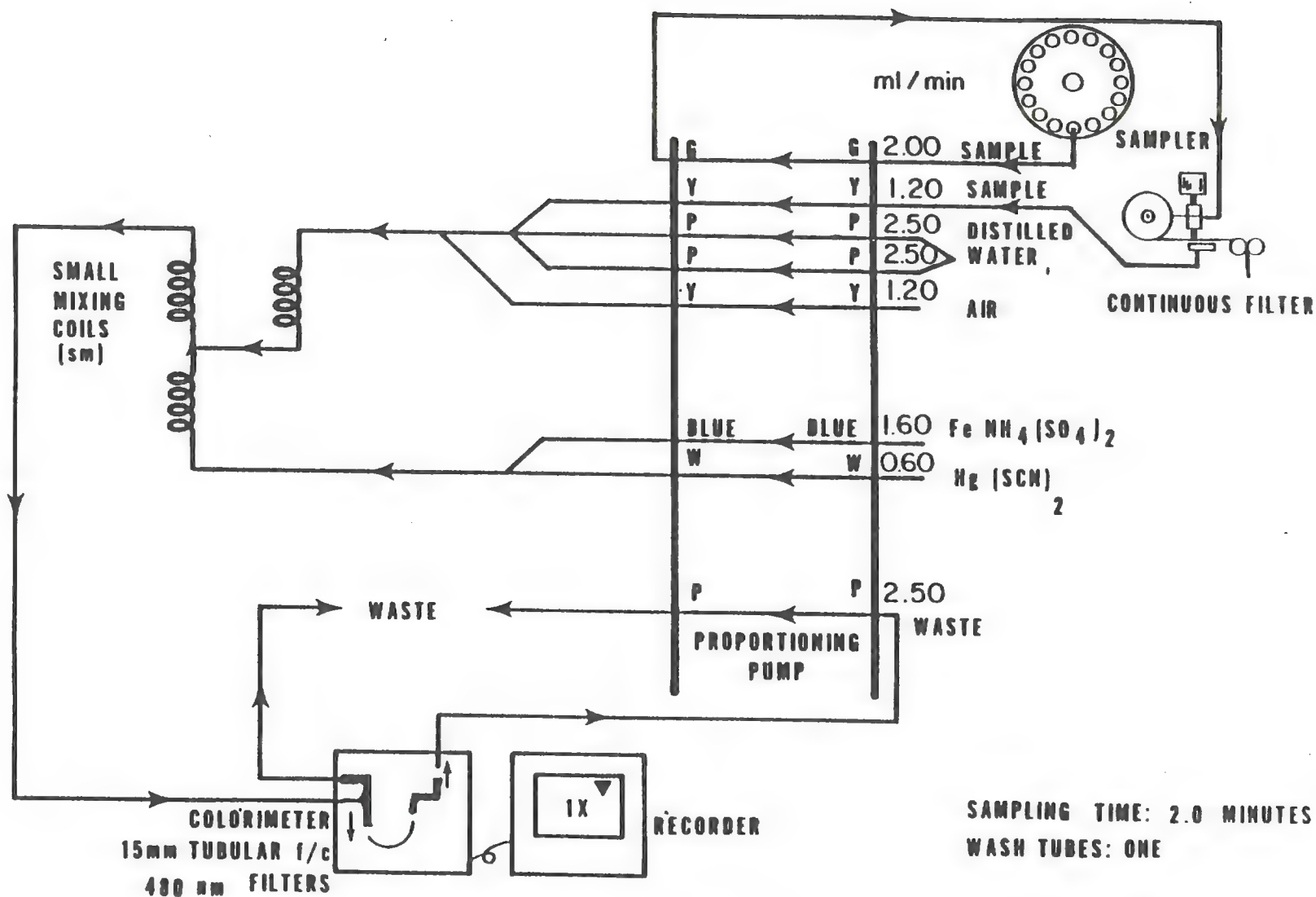


FIGURE 1. CHLORIDE MANIFOLD AA-1



**TOTAL DISSOLVED SOLIDS**

**METHOD 160.1**

**METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES  
(EPA, 1984)**





## RESIDUE, FILTERABLE

Method 160.1 (Gravimetric, Dried at 180°C)

STORET NO. 70300

1. Scope and Application
  - 1.1 This method is applicable to drinking, surface, and saline waters, domestic and industrial wastes.
  - 1.2 The practical range of the determination is 10 mg/l to 20,000 mg/l.
2. Summary of Method
  - 2.1 A well-mixed sample is filtered through a standard glass fiber filter. The filtrate is evaporated and dried to constant weight at 180°C.
  - 2.2 If Residue, Non-Filterable is being determined, the filtrate from that method may be used for Residue, Filterable.
3. Definitions
  - 3.1 Filterable residue is defined as those solids capable of passing through a glass fiber filter and dried to constant weight at 180°C.
4. Sample Handling and Preservation
  - 4.1 Preservation of the sample is not practical; analysis should begin as soon as possible. Refrigeration or icing to 4°C, to minimize microbiological decomposition of solids, is recommended.
5. Interferences
  - 5.1 Highly mineralized waters containing significant concentrations of calcium, magnesium, chloride and/or sulfate may be hygroscopic and will require prolonged drying, desiccation and rapid weighing.
  - 5.2 Samples containing high concentrations of bicarbonate will require careful and possibly prolonged drying at 180°C to insure that all the bicarbonate is converted to carbonate.
  - 5.3 Too much residue in the evaporating dish will crust over and entrap water that will not be driven off during drying. Total residue should be limited to about 200 mg.
6. Apparatus
  - 6.1 Glass fiber filter discs, 4.7 cm or 2.1 cm, without organic binder, Reeve Angel type 934-AH, Gelman type A/E, or equivalent.
  - 6.2 Filter holder, membrane filter funnel or Gooch crucible adapter.
  - 6.3 Suction flask, 500 ml.
  - 6.4 Gooch crucibles, 25 ml (if 2.1 cm filter is used).
  - 6.5 Evaporating dishes, porcelain, 100 ml volume. (Vycor or platinum dishes may be substituted).
  - 6.6 Steam bath.
  - 6.7 Drying oven, 180°C  $\pm$ 2°C.
  - 6.8 Desiccator.

Approved for NPDES  
Issued 1971

- 6.9 Analytical balance, capable of weighing to 0.1 mg.
7. Procedure
- 7.1 Preparation of glass fiber filter disc: Place the disc on the membrane filter apparatus or insert into bottom of a suitable Gooch crucible. While vacuum is applied, wash the disc with three successive 20 ml volumes of distilled water. Remove all traces of water by continuing to apply vacuum after water has passed through. Discard washings.
- 7.2 Preparation of evaporating dishes: If Volatile Residue is also to be measured heat the clean dish to  $550 \pm 50^\circ\text{C}$  for one hour in a muffle furnace. If only Filterable Residue is to be measured heat the clean dish to  $180 \pm 2^\circ\text{C}$  for one hour. Cool in desiccator and store until needed. Weigh immediately before use.
- 7.3 Assemble the filtering apparatus and begin suction. Shake the sample vigorously and rapidly transfer 100 ml to the funnel by means of a 100 ml graduated cylinder. If total filterable residue is low, a larger volume may be filtered.
- 7.4 Filter the sample through the glass fiber filter, rinse with three 10 ml portions of distilled water and continue to apply vacuum for about 3 minutes after filtration is complete to remove as much water as possible.
- 7.5 Transfer 100 ml (or a larger volume) of the filtrate to a weighed evaporating dish and evaporate to dryness on a steam bath.
- 7.6 Dry the evaporated sample for at least one hour at  $180 \pm 2^\circ\text{C}$ . Cool in a desiccator and weigh. Repeat the drying cycle until a constant weight is obtained or until weight loss is less than 0.5 mg.
8. Calculation
- 8.1 Calculate filterable residue as follows:

$$\text{Filterable residue, mg/l} = \frac{(A - B) \times 1,000}{C}$$

where:

A = weight of dried residue + dish in mg

B = weight of dish in mg

C = volume of sample used in ml

9. Precision and Accuracy
- 9.1 Precision and accuracy are not available at this time.

#### Bibliography

1. Standard Methods for the Examination of Water and Wastewater, 14th Edition, p 92, Method 208B, (1975).

**FINAL**  
**HEALTH AND SAFETY PLAN**  
**FOR THE**  
**ABANDONED MINES**  
**HAZARDOUS MATERIALS INVENTORY**

**Abandoned Mine Reclamation Bureau**  
**Montana Department of State Lands**  
**1625 11th Avenue**  
**Helena, Montana 59620**

**MAY 1993**





**FINAL**  
**HEALTH AND SAFETY PLAN**  
**FOR THE**  
**ABANDONED MINES HAZARDOUS MATERIALS INVENTORY**

**PREPARED FOR:**

**MR. VIC ANDERSON**  
**AND**  
**MR. EARL MCCURLEY**  
**ABANDONED MINE RECLAMATION BUREAU**  
**MONTANA DEPARTMENT OF STATE LANDS**  
**1625 11TH AVENUE**  
**HELENA, MONTANA 59620**

**PREPARED BY:**

**PIONEER TECHNICAL SERVICES, INC.**  
**P.O. Box 3445**  
**BUTTE, MONTANA 59702**

**AND**

**THOMAS, DEAN & HOSKINS, INC.**  
**1200 25TH ST. SOUTH**  
**GREAT FALLS, MONTANA 59405**

**MAY 1993**




ABANDONED MINES HAZARDOUS MATERIALS INVENTORY

HEALTH AND SAFETY PLAN

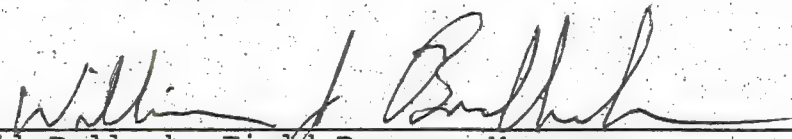
MAY 1993

I HAVE REVIEWED AND APPROVED THE HEALTH AND SAFETY PLAN FOR THE  
ABANDONED MINED HAZARDOUS MATERIALS INVENTORY.

Review and Approval:

  
Meg Babits, Corporate Health and Safety Officer  
Pioneer

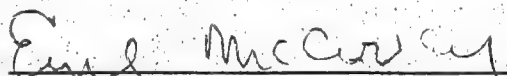
5-18-93  
Date

  
Bill Bullock, Field Program Manager  
Pioneer

5-18-93  
Date

  
Tim Ranf, Contractor Project Manager  
TD&H

5/18/93  
Date

  
Earl McCurley, Project Officer  
MDSL

5/18/93  
Date





ABANDONED MINES HAZARDOUS MATERIALS INVENTORY

HEALTH AND SAFETY PLAN

MAY 1993

I HAVE REVIEWED THE HEALTH AND SAFETY PLAN AND UNDERSTOOD THE HAZARDS PRESENTED ON THE PROJECT. I AGREE TO FOLLOW THE PROCEDURES OUTLINED IN THE PLAN AND TO INFORM THE HEALTH AND SAFETY OFFICER SHOULD ANY UNSAFE CONDITIONS BE NOTED. I UNDERSTAND THAT FAILURE TO FOLLOW SAFETY REGULATIONS CAN BE A REASON FOR REMOVAL FROM THE PROJECT.

John D. Belanger 5/18/93

Dawn R. Clark 5/18/93

Michael B. Loeber 5/18/93

J. Taylor Pearson 5/18/93

Don K. Eby 5/18/93

Margaret Balch 5/18/93

Julie Thompson 5/18/93

William J. Bullock



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**ABANDONED MINES HAZARDOUS MATERIALS INVENTORY**

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**APPENDIX A - HOSPITAL INFORMATION**

**APPENDIX B - DAILY SAFETY MEETING FORM**





## 1.0 INTRODUCTION

This document was prepared for the Montana Department of State Lands/Abandoned Mines Reclamation Bureau (MDSL/AMRB) by Pioneer Technical Services, Inc., (Pioneer) and Thomas, Dean & Hoskins, Inc., (TD&H) under the Engineering Services Agreement DSL-AMRB No.004 for FY92/93. This document describes health and safety for the Abandoned Mines Hazardous Materials Inventory. The purpose of the inventory is to collect chemical and physical data at abandoned mine sites that have the potential to impact human health and the environment. This Health and Safety Plan is a supporting document for the Sampling and Analysis Plan (Pioneer, 1993a), the Laboratory Analytical Protocol (Pioneer, 1993b), and the Quality Assurance Project Plan (Pioneer, 1993c).

The purpose of this document is to set forth the minimum acceptable requirements and procedures for a Health and Safety Plan for TD&H, Pioneer, and all other subcontractors. All work practices and procedures are designed to minimize exposure to hazardous materials and to eliminate any possibility of physical injury to TD&H employees, Pioneer employees, MDSL/AMRB personnel, other subcontractors, and the nearest communities. Work performed under this Health and Safety Plan shall be in accordance with applicable State of Montana Regulations, 29 CFR, Part 1910.120, and U.S. Environmental Protection Agency (EPA) Standard Operating Safety Guidelines.

The Abandoned Mines Hazardous Materials Inventory will take place from June 1, 1993 and proceed to completion; approximately 10-15 weeks. The logistics includes a minimum of two field sampling teams of three persons each. Each field team will have a field team leader, a field team member, and a X-ray Fluorescence (XRF) operator. The field team leaders will rotate among three Pioneer principals allowing one principal to remain in the office to coordinate data as needed. Because each field sampling team will perform at separate sites that may not be in close proximity, each field team leader will act as health and safety officer.

The background information for the sites is preliminary and based on the preliminary information the overall hazard is low.

## 2.0 ASSIGNMENT OF RESPONSIBILITIES

The members associated with the Abandoned Mines Hazardous Materials Inventory field sampling are listed below with their titles and responsibilities.

MDSL Project Officer - Earl McCurley, MDSL

The MDSL Project Officer will ensure that the terms of the contract, insofar as the field activities and the associated personnel and responsibilities in the performance of the field activities, are carried out satisfactorily.

Field Program Manager - Bill Bullock, Pioneer

The Field Program Manager is responsible for the overall implementation of the Health and Safety Plan. This includes communicating the requirements to all personnel, supervising field work, and making appropriate changes to the Plan.

Health and Safety Officer - Meg Babits, Bill Bullock, or Dave Tuesday, Pioneer

The Health and Safety Officer will ensure that work crews comply with all site health and safety requirements and will revise the plan if necessary.

Field Team Leaders - Bill Bullock, Meg Babits, or Dave Tuesday, Pioneer

The Field Team Leader ensures that the Sampling and Analysis Plan (SAP) (Pioneer, 1993a) has been established and is followed to implement field activities. Field team leaders will assist in field activities and document activities in the log book and are responsible for equipment, problem solving, and decision making in the field.

Field Team Members - Julie Flammang and Jodi Belanger - Pioneer; and, Taylor Pierson - TD&H

Field team members conduct the field activities with the field team leaders including sampling, monitoring, and decontamination procedures.

XRF Operators - Dawn Clark and Mike Lasher - Pioneer

XRF Operators are responsible for operating the field XRFs. The operators may also assist in sampling activities if XRF analysis requirements are low.

### 3.0 PROJECT DESCRIPTION

The Abandoned Mines Hazardous Materials Inventory includes approximately 270 sites in 23 counties throughout Montana. The topography will range from gently sloping land in floodplains to very steep mountainous areas. The land has been identified as public lands (U.S. Department of Agriculture/Forest Service, U.S.

Department of Interior/Bureau of Land Management, Montana Department of State Lands, etc.) or patented lands (private). The project consists of inactive/abandoned mine sites; however, exploration may be being conducted at the sites.

Significant features at each of the sites may include tailings ponds, impoundments, and piles; waste rock dumps or piles; mine adits, pits, shafts, and dumps; miscellaneous buildings (and associated asbestos) and structures; roads; chemical or fuel storage (barrels or tanks); fencing; and, miscellaneous power supply items (poles, transformers, lines, etc.). The sites may support wildlife, domestic grazing, or aquatic life. Residential occupation of the site is not expected, but residences adjacent to sites may be encountered.

Field activities are detailed in the SAP (Pioneer, 1993a). Some items to be performed include: water pH, alkalinity, specific conductance (SC), temperature, and EH measurements, flow measurements, and sampling; solid (soil, sediment, mine tailings, waste rock, etc.) pH and radioactivity measurements, texture, and sampling; XRF analyses; and, mapping.

#### **4.0 HEALTH AND SAFETY**

##### **4.1 INITIAL HEALTH AND SAFETY TRAINING**

All personnel (leaders, members, and operators) associated with sampling activities during the Abandoned Mines Hazardous Materials Inventory field sampling must have completed the 40-hour initial training per 29 CFR, Part 1910.120 and the subsequent 8-hour refresher training, if applicable. These personnel are required to participate in a medical monitoring program. At least one person per team will have the 8-hour manager and supervisor training per 29 CFR, Part 1910.120 and current first aid and cardiopulmonary resuscitation (CPR) training. Proof of certification is required on-site. Significant safety issues and safe working practices will be provided during the first week of sampling in order to satisfy the 24-hour OSHA training requirement.

##### **4.2 VISITORS**

Visitors must log in with the field team leader. Visitors who are not exposed to excavation (sampling) of materials are not considered at risk; therefore, they are considered exempt from the above training requirements. Visitors will be allowed access to the excavation (sampling) areas if they demonstrate compliance with 29 CFR, Part 1910.120 (e).



#### 4.3 REVIEW OF HEALTH AND SAFETY PLAN

All personnel will review the Health and Safety Plan prior to the start of work and are expected to work in accordance with the Health and Safety Plan. The Field Project Manager will be notified of any situation presenting a risk that has not been addressed in the plan.

#### 4.4 HEALTH AND SAFETY MEETINGS

A Health and Safety meeting will be conducted at each site, prior to starting work, to cover the suspected hazards expected for that days work and the precautions necessary to deal with the hazards. The site-specific safety meeting form in Appendix B will be completed by the field team leader/health and safety officer. If any unusual situation arises that might present an unsafe condition and was not discussed in the Health and Safety meeting, the Field Team Leaders will stop work until an assessment of the problem has been made. All safety incidences will be documented on the safety form.

In the case of an emergency, all workers will be evacuated from the site. The Health and Safety Officer is expected to notify the field team members of the closest hospital (Appendix A) to that day's site and the appropriate route to the hospital. Emergency medical personnel, fire suppression, and law enforcement are available throughout Montana by dialing 0.

#### 4.5 DESCRIPTION OF SITE HAZARDS

Specific hazards include skin contact and inhalation with soil, mill tailings, or water containing heavy metals. Contaminants suspected at the site and pertinent hazard information from the, "Threshold Limit Values," (ACGIH, 1992) and "Rapid Guide to Hazardous Chemicals in the Workplace," (Sax, 1986) are listed below. The typical compounds of concern include the following metals: Antimony, Arsenic, Barium, Cobalt, Cadmium, Chromium, Copper, Iron, Mercury, Manganese, Nickel, Lead, Zinc and Cyanide.

Antimony: the threshold limit value-time weighted average (TLV-TWA) (the concentration which a worker can be exposed to in an 8-hour day in a 40-hour week without adverse effects) is 0.5 mg/m<sup>3</sup>. Symptoms of exposure are irritation to skin, gastrointestinal upset, and nervous system complaints.

Arsenic: is currently a suspected human carcinogen (A2) and is proposed as a confirmed human carcinogen (A1). The TLV-TWA is 0.2 mg/m<sup>3</sup>.

Barium: the TLV-TWA is 0.5 mg/m<sup>3</sup>. Symptoms of exposure are severe abdominal pain, vomiting, dyspnoea, rapid pulse, paralysis of arm and leg, and eventually coma and death.

Cadmium: the TLV-TWA is currently 0.05 mg/m<sup>3</sup>. Cadmium is a proposed suspected human carcinogen (A2). Exposure causes sudden nausea, salivation, vomiting, diarrhea, abdominal pain, and discomfort.

Copper: the TLV-TWA is 1.0 mg/m<sup>3</sup>. Symptoms of exposure are vomiting, gastric pain, dizziness, exhaustion, anemia, cramps, convulsions, shock, coma, death. Copper can damage nervous system and kidneys.

Lead: the TLV-TWA is 0.15 mg/m<sup>3</sup>. Lead damages the central nervous system.

Mercury: the TLV-TWA is 0.05 mg/m<sup>3</sup>. Mercury's main effect is on the central nervous system.

Silver: the TLV-TWA is 0.01 mg/m<sup>3</sup>. Symptoms of exposure include grayish green discoloration of the skin, mumen, and eyes.

Zinc: the TLV-TWA is 10 mg/m<sup>3</sup>. Symptoms of exposure are sweet taste, dry throat, cough, weakness, generalized aching, fever, nausea, and vomiting. Zinc exposure is not cumulative; but has caused fatal lung damage.

#### 4.6 PERSONAL PROTECTIVE EQUIPMENT REQUIREMENTS

All personnel involved with the field operations will use Level D personal protective equipment (PPE), which includes coveralls and safety boots. Other equipment may be used under Level D as appropriate including hard hat, gloves, or safety glasses. The PPE will be upgraded if visible dust is present at the site. The upgrade will be to modified Level C, which includes all equipment in Level D plus a NIOSH full-face air purifying respirator and chemical resistant gloves. Respirators with particulate cartridges are to be used.

#### 4.7 PERSONAL/EQUIPMENT DECONTAMINATION

The following list details decontamination of on-site personnel and equipment.

- All equipment will be decontaminated prior to use and prior to leaving the site. Decontamination consists of a tap water rinse, a soap and tap water wash, a distilled water rinse, and a nitric acid rinse.
- Decontamination fluids will be disposed to the ground surface leaving any site hazardous material on-site.
- Personnel will wash hands prior to drinking or eating.

- Eating and drinking areas will be separated from the excavation (sampling area) and determined by the Health and Safety Officer.
- Respirators will not be removed until coveralls are removed.
- Respirator cartridges will be discarded after one day's use.

#### 4.8 ADDITIONAL HAZARDS

The potential for heat emergencies to personnel will be mild to significant based on the PPE being worn, the ambient temperature, and the amount of activity. Threat of heat emergencies will be reduced by consuming plenty of water. Employees are to report any case of dizziness, excessive sweating, increased respiratory rate, or pulse. Heat stroke is life-threatening; symptoms are hot, red skin, very small pupils and a very high body temperature. The heat stroke victim should be transported immediately to medical help; get the individual out of the heat and into a cooler place. Heat exhaustion is less dangerous; symptoms are cool, pale, moist skin, headache, nausea, heavy sweating, vomiting, dilated pupils, and dizziness. The heat exhaustion victim should get out of the heat and into a cooler place, cool with fanning or wet towels, and give water.

Work cycle lengths will be reduced and a monitoring program will be initiated if any of the above are noted. Monitoring includes shifts in body weight and pulse rate.

The potential for cold emergencies is also possible. Threat of cold emergencies will be reduced by carrying hats and gloves. Frostbite may first be noted by skin that is slightly flushed. The skin then changes to white or grayish yellow and finally grayish blue. Pain may be felt early then the feeling is very cold and numb. The individual with frostbite should be removed from the cold and the body parts put in warm water. Hypothermia may be noted by shivering, dizziness, numbness, confusion, weakness, impaired vision, and drowsiness. The hypothermia victim should be transported immediately to medical help; get the individual out of the cold and into dry clothing with no water or food.

Insect bites should have the stinger removed using tweezers, wash, and apply ice. Some insect bites can cause emergencies to those who suffer allergic reactions. All field team members should report allergies to the field team leaders or corporate health and safety officer. If an allergic reaction occurs, the individual should be immediately transported to medical help. Snake bite victims should also be immediately transported to medical help.

Other hazards include wildfires and wildlife. Personnel should be cognizant of the conditions they are being exposed to daily and leave the site when they occur in close proximity.



The steep settings of some abandoned mine sites present a safety hazard. The SAP requires sampling of the sides of dumps off the crest. The field team members must determine if fall hazards are present and reposition sampling locations if necessary.

The field teams will not enter any underground mine workings because of possible deterioration of supports and lack of ventilation. The field teams will stay on established roads and trails when possible to avoid underground mine openings (shafts, adits, etc.) that may not be visible. If off-road or trail travel is necessary, it will be discussed in the daily safety meeting to heighten the awareness of the field team.

The field teams may have to enter buildings to assess for asbestos, barrels, etc. A survey of the building should be made prior to entry. The roof and floor should be evaluated for competency.

#### 4.9 GENERAL HEALTH AND SAFETY RULES

The following is a list of general health and safety rules that will be enforced.

- Each field team is required to carry a standard first aid kit.
- The sites will always be visited with a minimum of a two person team.
- Sampling will only take place during the daylight hours.
- Radios will be used for communication between teams.

#### 4.10 INVESTIGATION DERIVED WASTE

An attempt will be made to use nondisposable items in the Abandoned Mines Hazardous Materials Inventory; disposal of waste is in accordance with EPA protocols (EPA, 1991). The following will be the methods of handling investigation derived waste.

- Decontamination fluids will be disposed to the ground surface leaving any site hazardous material on-site.
- Soil cuttings will be returned to the borehole.
- PPE will be double bagged and disposed of at a municipal landfill.
- Laboratories will dispose of the unused portions of the soil and water samples not used for analysis.



## 5.0 XRF SAFETY

The chemical characterization of solid samples (soil, tailings, waste rock, etc.) in the field will be determined by the field portable XRF spectrometer 9000 instrument manufactured by Spectrace Instruments, Inc., Fort Collins, Colorado. The instrument has a mercuric iodide ( $\text{HgI}_2$ ) conductor and three shielded radioactive sources (Fe-55, Cd-109, and Am-241) that produce spectral peaks. The manufacturer states that no personal dosimetry is required for the radioactive source because of the high quality aluminum shielding.

## 6.0 REFERENCES

- American Conference of Governmental Industrial Hygienists, 1992. Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices.
- Pioneer, 1993a. Sampling and Analysis Plan for the Abandoned Mines Hazardous Materials Inventory. May 1993.
- Pioneer, 1993b. Laboratory Analytical Protocol for the Abandoned Mines Hazardous Materials Inventory. May 1993.
- Pioneer, 1993c. Quality Assurance Project Plan for the Abandoned Mines Hazardous Materials Inventory. May 1993.
- Sax, Irving N. and Richard J. Lewis, Sr., 1986. Rapid Guide to Hazardous Chemicals in the Workplace.
- U.S. Environmental Protection Agency, 1991. Management of Investigation Derived Wastes During Site Inspections.

**APPENDIX A**  
**HOSPITAL INFORMATION**



The following is a list of towns and cities where field team members and leaders will be based over the project duration. The cities and towns have the nearest hospital listed.

Big Timber

Bozeman Deaconess Hospital  
915 Highland Blvd.  
Bozeman, MT 59715  
406-585-1000

Elliston

St. Peter Community Hospital  
2475 Broadway  
Helena, MT 59601  
406-442-2480

Bozeman

Bozeman Deaconess Hospital  
915 Highland Blvd.  
Bozeman, MT 59715  
406-585-1000

Hamilton

Marcus Daly Community Hospital  
1200 Westwood Drive  
Hamilton, MT 59840  
406-363-2211

Butte

St. James Community  
Hospital, Inc.  
400 S. Clark  
Butte, MT 59701  
406-782-8361

Helena

St. Peter Community Hospital  
2475 Broadway  
Helena, MT 59601  
406-442-2480

Columbus

Stillwater Community  
Hospital  
44 W 4th Ave. N.  
Columbus, MT 59019  
406-322-5316

Kalispell

Kalispell Regional Hospital  
310 Sunny View Lane  
Kalispell, MT 59901  
406-755-5111

Cooke City

Livingston Memorial  
Hospital  
504 South 13  
Livingston, MT 59047  
406-222-3541

Lewistown

Central Montana Medical Center  
408 Wendell Ave.  
Lewistown, MT 59457  
406-538-7711

Dillon

Barrett Memorial Hospital  
1260 S. Atlantic  
Dillon, MT 59725  
406-683-2323

Missoula

St. Patrick Hospital  
Spruce and McCormick  
Missoula, MT 59802  
406-543-7271



Monarch

Columbus Hospital  
500 15th Ave. S.  
Great Falls, MT 59405  
406-727-3333

Neihart

Columbus Hospital  
500 15th Ave. S.  
Great Falls, MT 59405  
406-727-3333

Philipsburg

Granite County Memorial  
Hospital  
Philipsburg, MT 59858  
406-859-3271

Superior

Mineral County Hospital  
Brooklyn and Roosevelt  
Superior, MT 59872  
406-822-4841

Thompson Falls

Clark Fork Valley Hospital  
1008 Main  
Thompson Falls, MT 59873  
406-827-3659

Townsend

Broadwater Health Center  
110 N. Oak  
Townsend, MT 59644  
406-266-3186

Virginia City

Madison Valley Hospital  
Ennis, MT 59729  
406-682-4274

White Sulphur Springs

Mountain View Memorial  
Hospital  
16 W. Main  
White Sulphur Springs, MT  
59645  
406-547-1005

**APPENDIX B**  
**DAILY SAFETY MEETING FORM**



AMRB HAZARDOUS MATERIALS INVENTORY  
SITE-SPECIFIC SAFETY MEETING FORM

SITE NAME \_\_\_\_\_ P.A. # \_\_\_\_\_

FIELD TEAM LEADER \_\_\_\_\_

FIELD TEAM MEMBER AND XRF OPERATOR \_\_\_\_\_

MINE OPENINGS (NUMBER AND LOCATION) \_\_\_\_\_

NEAREST HOSPITAL LOCATED \_\_\_\_\_

WILDLIFE DANGERS \_\_\_\_\_

FOREST FIRE DANGER \_\_\_\_\_

EVACUATION ROUTE/PROCEDURE \_\_\_\_\_

PERSONNEL MEDICAL CONDITIONS \_\_\_\_\_

SAFETY OR MEDICAL INCIDENTS AND ACTIONS WHILE ON SITE \_\_\_\_\_

FIELD TEAM LEADER SIGNATURE AND DATE \_\_\_\_\_

FIELD TEAM SAMPLER SIGNATURE AND DATE \_\_\_\_\_

XRF OPERATOR SIGNATURE AND DATE \_\_\_\_\_





## INVESTIGATION

| SITE NAME              | PA No. | DATE    | TAPE No. | #1LOG<br>START | FINISH |
|------------------------|--------|---------|----------|----------------|--------|
| Ermont Mill & Mines    | 01-005 | 6/14/93 | 1        | 2433           | 2831   |
| Apex Millsite          | 01-006 | 9/16/93 | No Video |                |        |
| Gold Leaf/Priscilla    | 01-031 | 9/16/93 | 6        | 5391           | 5595   |
| Indian Queen           | 01-034 | 6/15/93 | 1        | 2831           | 2932   |
| Garrett Hill           | 01-092 | 9/15/93 | 6        | 5275           | 5391   |
| Silver King            | 01-094 | 8/26/93 | 6        | 0              | 148    |
| Lower Cleve            | 01-143 | 9/14/93 | 6        | 4895           | 5080   |
| Trapper                | 01-144 | 8/26/93 | 6        | 148            | 487    |
| Old Elkhorn            | 01-169 | 9/15/93 | 6        | 5188           | 5275   |
| Tungsten Millsite      | 01-170 | 9/13/93 | 6        | 4730           | 4895   |
| South Frying Pan       | 01-211 | 8/25/93 | 5        | 5664           | 5735   |
| Last Chance No. 1      | 01-216 | 8/25/93 | 5        | 5520           | 5615   |
| Last Chance No. 2      | 01-220 | 8/25/93 | 5        | 5615           | 5664   |
| Clara                  | 01-262 | 8/13/93 | 5        | 3123           | 3232   |
| Martin                 | 01-270 | 9/09/93 | 6        | 4233           | 4308   |
| East Pacific           | 04-008 | 7/27/93 | 1        | 4771           | 4830   |
| Ohio                   | 04-009 | 9/03/93 | 6        | 2770           | 2935   |
| Park (Marietta)        | 04-012 | 7/27/93 | 4        | 4165           | 4414   |
| St. Louis              | 04-013 | 7/27/93 | 4        | 4414           | 4559   |
| Vosburg                | 04-014 | 7/27/93 | 1        | 4725           | 4771   |
| Argo                   | 04-015 | 7/26/93 | No video |                |        |
| Diamond Hill           | 04-020 | 7/28/93 | 1        | 4830           | 4899   |
| Keatings Tailings      | 04-121 | 9/03/93 | 6        | 2935           | 3188   |
| Miller Mtn.            | 04-138 | 7/26/93 | 1        | 4698           | 4725   |
| Hummingbird            | 04-144 | 7/26/93 | No video |                |        |
| Vilipa                 | 07-080 | 7/29/93 | 4        | 5148           | 5506   |
| Molton                 | 07-084 | 7/29/93 | 4        | 5506           | 5625   |
| Evening Star Mill      | 07-087 | 6/2/93  | 2        | 700            | 1075   |
| Bon Ton                | 07-094 | 6/3/93  | 2        | 1075           | 1269   |
| Compromise             | 07-100 | 6/1/93  | No video |                |        |
| Carpenter Ck. Tailings | 07-103 | 5/24/93 | 1        | 0              | 110    |
| Rochester              | 07-110 | 6/2/93  | No video |                |        |
| Silver Belt            | 07-111 | 7/30/93 | 1        | 4993           | 5035   |
| Fairplay               | 07-112 | 7/30/93 | 1        | 5035           | 5058   |
| Atlantus               | 07-113 | 6/2/93  | No video |                |        |
| Stallabrax             | 07-120 | 7/30/93 | No video |                |        |
| Dakotah                | 07-121 | 6/8/93  | 2        | 1918           | 2350   |
| Maud S.                | 07-129 | 6/8/93  | No video |                |        |
| Neihart Tailings       | 07-134 | 6/2/93  | 2        | 120            | 700    |
| Silver Dike Adit       | 07-135 | 6/1/93  | No video |                |        |
| Silver Dyke Millsite   | 07-137 | 5/25/93 | 1        | 110            | 292    |
| Silver Dyke Tailings   | 07-137 | 5/26/93 | 1        | 292            | 523    |
| Sherman No. 2          | 07-140 | 5/26/93 | 1        | 523            | 614    |
| Sherman No. 2          | 07-142 | 5/26/93 | No video |                |        |
| Big Seven              | 07-156 | 5/27/93 | 1        | 614            | 692    |
| Baker                  | 07-180 | 7/29/93 | No video |                |        |
| Cable                  | 12-002 | 9/10/93 | 3        | 3642           | 3665   |
| Champion               | 12-003 | 7/16/93 | 4        | 3298           | 3573   |
| Gold Coin              | 12-004 | 6/25/93 | No video |                |        |

## INVESTIGATION

| SITE NAME                    | PA No. | DATE    | TAPE No. | #1LOG | FINISH |
|------------------------------|--------|---------|----------|-------|--------|
|                              |        |         |          | START |        |
| Silver Lake Millsite         | 12-070 | 6/25/93 | 2        | 5338  | 5540   |
| Tail Holt                    | 14-010 | 9/11/93 | 6        | 4467  | 4592   |
| Cumberland                   | 14-017 | 9/11/93 | 6        | 4592  | 4730   |
| Flathead Mine                | 15-012 | 8/05/93 | 1        | 5321  | 5394   |
| Elk Creek Corundum           | 16-013 | 8/12/93 | 1        | 5728  | 5741   |
| Thumper Mica                 | 16-015 | 8/12/93 | 5        | 3015  | 3123   |
| Karst Asbestos               | 16-018 | 8/13/93 | 1        | 5741  | 5770   |
| Bi-Metallic/Old Red          | 20-002 | 6/22/93 | 1        | 2420  | 2433   |
| Douglas Creek                | 20-003 | 6/23/93 | 2        | 4750  | 5075   |
| Forest Rose                  | 20-004 | 6/29/93 | 4        | 5     | 606    |
| Algonquin                    | 20-005 | 6/23/93 | No video |       |        |
| Combination                  | 20-009 | 7/21/93 | 4        | 3573  | 3748   |
| Nonpareil                    | 20-012 | 9/08/93 | 3        | 3195  | 3394   |
| Rumsey Mine/Millsite         | 20-018 | 6/24/93 | No video |       |        |
| Scratch All                  | 20-019 | 6/22/93 | 2        | 4538  | 4750   |
| Wasa                         | 20-023 | 6/29/93 | 1        | 3120  | 3143   |
| Brooklin                     | 20-025 | 6/24/93 | 2        | 5075  | 5338   |
| Jackson Park                 | 20-027 | 6/29/93 | 1        | 3265  | 3357   |
| Trout                        | 20-062 | 6/21/93 | 2        | 4125  | 4453   |
| Alps                         | 20-065 | 6/30/93 | 1        | 3244  | 3265   |
| Granite Mtn.                 | 20-110 | 6/22/93 | 1        | 2390  | 2420   |
| True Fissure                 | 20-111 | 6/23/93 | No video |       |        |
| Banner                       | 20-175 | 6/21/93 | 1        | 2290  | 2349   |
| Old Dominion                 | 20-180 | 6/21/93 | 1        | 2349  | 2390   |
| Silver King                  | 20-186 | 6/30/93 | 4        | 606   | 966    |
| Lori No. 13                  | 20-191 | 9/10/93 | 3        | 3605  | 3642   |
| Ant                          | 20-194 | 9/09/93 | 3        | 3500  | 3605   |
| Maxville Tails (Londonderry) | 20-209 | 9/09/93 | 3        | 3394  | 3500   |
| Alta                         | 22-001 | 8/17/93 | 5        | 3685  | 3876   |
| Bertha                       | 22-002 | 7/12/93 | 4        | 1425  | 2045   |
| Blue Bird                    | 22-003 | 7/08/93 | 1        | 4307  | 4357   |
| Bluebird                     | 22-003 | 7/08/93 | 2        | 4530  | 4588   |
| Corbin Flats                 | 22-004 | 7/12/93 | 1        | 4525  | 4570   |
| Gregory                      | 22-005 | 8/17/93 | 5        | 3876  | 4215   |
| Washington                   | 22-007 | 8/16/93 | 5        | 3232  | 3530   |
| Bullion                      | 22-008 | 7/06/93 | No video |       |        |
| Comet Tailings               | 22-009 | 7/08/93 | No video |       |        |
| Elkhorn Queen                | 22-027 | 8/16/93 | 3        | 309   | 472    |
| Grey Eagle                   | 22-029 | 7/09/93 | No video |       |        |
| Mantle (East)                | 22-032 | 7/07/93 | No video |       |        |
| Basin Millsite               | 22-036 | 7/09/93 | 1        | 4424  | 4488   |
| Perry's Park                 | 22-039 | 7/09/93 | 1        | 4488  | 4525   |
| Middle Fk. Warm Springs      | 22-046 | 8/17/93 | 3        | 472   | 680    |
| Alhambra Hot Springs         | 22-049 | 8/17/93 | 3        | 680   | 800    |
| Solar Silver                 | 22-054 | 8/17/93 | No video |       |        |
| Buckeye                      | 22-072 | 7/06/93 | No video |       |        |
| Crystal                      | 22-073 | 7/07/93 | No video |       |        |
| Enterprise                   | 22-074 | 7/06/93 | No video |       |        |
| Eva May                      | 22-075 | 7/07/93 | No video |       |        |

## INVESTIGATION

| SITE NAME              | PA No. | DATE         | TAPE No. | #1LOG<br>START | FINISH |
|------------------------|--------|--------------|----------|----------------|--------|
| Morning Glory          | 22-077 | 7/07/93      | No video |                |        |
| Argentine              | 22-102 | 8/16/93      | 5        | 3530           | 3685   |
| Minah Mine             | 22-104 | 7/09/93      | 1        | 4411           | 4424   |
| Queen (Tourmaline)     | 22-111 | 8/16/93      | 3        | 206            | 309    |
| Nellie Grant           | 22-244 | 5/18 & 19/93 | 2        | 0              | 120    |
| General Grant          | 22-245 | 5/19/93      | No video |                |        |
| Tacoma                 | 22-284 | 8/16/93      | 3        | 0              | 206    |
| Jack Creek Tailings    | 22-296 | 7/06/93      | No video |                |        |
| Marguerite             | 22-301 | 7/09/93      | 1        | 4357           | 4411   |
| Sourdough              | 22-336 | 8/20/93      | 3        | 1263           | 1355   |
| Wickes Tailings        | 22-358 | 8/17/93      | 5        | 4215           | 4402   |
| Galena Creek Sampling  | 23-001 | 6/7/93       | No video |                |        |
| Marcelline             | 23-022 | 6/4/93       | 2        | 1575           | 1720   |
| Vortex                 | 23-027 | 9/10/93      | 6        | 4308           | 4392   |
| Belt Patent            | 23-035 | 6/4/93       | 1        | 983            | 1031   |
| Lucky Strike           | 23-042 | 6/4/93       | 1        | 1031           | 1092   |
| Wright Lode            | 23-045 | 6/7/93       | 2        | 1720           | 1918   |
| Edwards Lode           | 23-046 | 6/7/93       | No video |                |        |
| Harrison               | 23-056 | 6/3/93       | 2        | 1269           | 1575   |
| Moulton                | 23-058 | 6/3/93       | 1        | 904            | 983    |
| Tiger                  | 23-059 | 6/3/93       | 1        | 692            | 904    |
| NE NE S31              | 23-079 | 9/10/93      | 6        | 4392           | 4467   |
| Tenmile                | 25-005 | 7/15/93      | 1        | 3609           | 3797   |
| Red Water              | 25-007 | 7/13/93      | 4        | 2205           | 2430   |
| Valley Forge/Susie     | 25-008 | 7/13/93      | 4        | 2045           | 2205   |
| Victory/ Evening Star  | 25-010 | 7/15/93      | 4        | 2700           | 2850   |
| Red Mtn. No. 13        | 25-019 | 8/19/93      | 5        | 4852           | 4984   |
| Red Mtn. (North)       | 25-019 | 8/20/93      | 5        | 5045           | 5145   |
| Seven-Up Pete/Rover    | 25-020 | 9/07/93      | 3        | 2960           | 3033   |
| Lower Tenmile/Engstrom | 25-030 | 7/15/93      | 1        | 3797           | 3836   |
| Davis Gulch            | 25-040 | 8/19/93      | 5        | 4984           | 5045   |
| Bald Mtn.              | 25-061 | 8/19/93      | 3        | 1134           | 1263   |
| Spring Hill Tailings   | 25-067 | 8/30/93      | 6        | 1002           | 1499   |
| Lady Luck              | 25-073 | 8/30/93      | 6        | 1499           | 1595   |
| Armstrong              | 25-102 | 7/15/93      | 4        | 3000           | 3298   |
| Beatrice               | 25-103 | 7/13/93      | 1        | 3448           | 3506   |
| Beatrice               | 25-103 | 7/13/93      | 1        | 4570           | 4698   |
| Big Ox Millsite        | 25-115 | 6/9/93       | 1        | 1317           | 1422   |
| Big Ox Mine            | 25-116 | 6/9/93       | 1        | 1092           | 1317   |
| Belmont                | 25-167 | 8/19/93      | 3        | 1021           | 1134   |
| Piegan/Gloster Mill    | 25-172 | 9/01/93      | 3        | 2830           | 2960   |
| Empire Mill            | 25-175 | 6/9/93       | 1        | 1422           | 1506   |
| Bald Butte Millsite    | 25-179 | 8/18/93      | 3        | 800            | 930    |
| NE NW S13              | 25-197 | 8/30/93      | 3        | 2406           | 2616   |
| Swawnsea Tailings      | 25-208 | 9/01/93      | 6        | 2068           | 2165   |
| SE SW S10              | 25-212 | 8/30/93      | 3        | 2616           | 2661   |
| Pangewasset            | 25-226 | 8/31/93      | 3        | 2661           | 2725   |
| Astor                  | 25-227 | 8/31/93      | 3        | 2725           | 2830   |
| Upper Valley Forge     | 25-280 | 8/20/93      | 5        | 5145           | 5260   |



| SITE NAME             | PA No. | INVESTIGATION |          | #1LOG | START | FINISH |
|-----------------------|--------|---------------|----------|-------|-------|--------|
|                       |        | DATE          | TAPE No. |       |       |        |
| SE SE S13             | 25-294 | 8/19/93       | 5        |       | 4767  | 4852   |
| Argo Millsite         | 25-314 | 9/02/93       | No video |       |       |        |
| Wildcat               | 25-317 | 8/18/93       | 3        |       | 930   | 1021   |
| Blackfoot Tailings    | 25-322 | 9/07/93       | 3        |       | 3033  | 3195   |
| Franklin              | 25-339 | 8/31/93       | 6        |       | 1663  | 2068   |
| Mother Lode           | 25-363 | 8/31/93       | 6        |       | 1595  | 1663   |
| Goldsil Millsite      | 25-365 | 9/02/93       | 6        |       | 2165  | 2770   |
| Snowshoe              | 27-005 | 8/04/93       | 1        |       | 5258  | 5304   |
| Cherry Creek Millsite | 27-006 | 8/04/93       | 1        |       | 5304  | 5321   |
| Mitchell Creek        | 27-055 | 8/04/93       | 5        |       | 620   | 827    |
| Silver Cable          | 27-066 | 8/04/93       | No video |       |       |        |
| Norwegian             | 29-006 | 9/13/93       | 3        |       | 3665  | 3779   |
| Mammoth               | 29-008 | 7/19/93       | 1        |       | 4114  | 4211   |
| Smuggler              | 29-010 | 6/16/93       | 1        |       | 1923  | 1927   |
| Smuggler              | 29-010 | 6/16/93       | 2        |       | 3555  | 3835   |
| Boaz                  | 29-013 | 9/13/93       | 3        |       | 3779  | 3874   |
| Atlantic & Pacific    | 29-033 | 9/15/93       | 3        |       | 4262  | 4385   |
| Boss Tweed            | 29-034 | 9/14/93       | 3        |       | 4078  | 4207   |
| Strawberry            | 29-038 | 9/14/93       | 3        |       | 3874  | 4078   |
| Emma                  | 29-061 | 6/18/93       | 1        |       | 2152  | 2290   |
| Thistle No. 1         | 29-073 | 6/15/93       | 2        |       | 2615  | 3386   |
| Watseca Mill          | 29-075 | 9/20/93       | 6        |       | 5686  | 5745   |
| Goldschmidt-Steiner   | 29-078 | 8/25/93       | 3        |       | 1631  | 1750   |
| Red Pine              | 29-079 | 8/25/93       | 3        |       | 1750  | 1825   |
| Mammoth Tailings      | 29-082 | 7/19/93       | 1        |       | 4211  | 4255   |
| B&H                   | 29-083 | 7/23/93       | No video |       |       |        |
| Kearsage              | 29-102 | 7/20/93       | 1        |       | 4291  | 4307   |
| General Shafter       | 29-103 | 7/21/93       | No video |       |       |        |
| Apex                  | 29-105 | 7/20/93       | 1        |       | 4255  | 4291   |
| JTC                   | 29-106 | 8/27/93       | 3        |       | 2127  | 2202   |
| Pacific               | 29-118 | 8/26/93       | 3        |       | 1825  | 1965   |
| Easton                | 29-121 | 8/26/93       | 3        |       | 1965  | 2127   |
| Broadway/Victoria     | 29-179 | 9/17/93       | 3        |       | 4207  | 4262   |
| Dry Gulch (South)     | 29-282 | 7/20/93       | No video |       |       |        |
| Eleanor East          | 29-285 | 9/04/93       | 6        |       | 3188  | 3305   |
| Broad Gauge           | 29-293 | 6/16/93       | 2        |       | 3386  | 3555   |
| Latest Out            | 29-354 | 6/17/93       | 1        |       | 1927  | 2140   |
| Missouri              | 29-373 | 7/22/93       | No video |       |       |        |
| Uncle Sam             | 29-383 | 6/16/93       | 1        |       | 1810  | 1923   |
| SE SE S25             | 29-394 | 9/20/93       | 3        |       | 4385  | 4418   |
| Grubstake             | 29-399 | 7/22/93       | No video |       |       |        |
| Lakeshore             | 29-436 | 7/21/93       | No video |       |       |        |
| Pete & Joe            | 29-449 | 7/23/93       | No video |       |       |        |
| Buckeye               | 29-451 | 8/27/93       | 3        |       | 2202  | 2406   |
| Pedro                 | 29-455 | 6/18/93       | 2        |       | 3925  | 4125   |
| Ohio                  | 29-473 | 7/20/93       | No video |       |       |        |
| SE SW S26 (Keynote)   | 29-474 | 6/16/93       | 2        |       | 3835  | 3925   |
| NE SE S26             | 29-476 | 6/17/93       | 1        |       | 2140  | 2152   |
| Cumberland            | 30-004 | 7/29/93       | 1        |       | 4940  | 4993   |

## INVESTIGATION

| SITE NAME                   | PA No. | DATE    | TAPE No. | #1LOG<br>START | FINISH |
|-----------------------------|--------|---------|----------|----------------|--------|
| Belle Of the Castle         | 30-007 | 7/29/93 | 1        | 4899           | 4940   |
| SE NW S24                   | 30-017 | 7/28/93 | 4        | 4828           | 4936   |
| Lane                        | 30-019 | 7/28/93 | 4        | 4936           | 5010   |
| Bigler                      | 30-067 | 7/28/93 | 4        | 4559           | 4773   |
| Porcupine                   | 30-069 | 7/28/93 | 4        | 4773           | 4828   |
| SE NE S10                   | 30-078 | 7/28/93 | 4        | 5010           | 5148   |
| Nancy Lee Mine              | 31-001 | 8/02/93 | 1        | 5088           | 5160   |
| Tarbox-Mineral King         | 31-003 | 8/02/93 | 4        | 5625           | 5729   |
| Iron Mountain Millsite      | 31-010 | 7/22/93 | 4        | 3823           | 4048   |
| Salteste Consolidate        | 31-021 | 8/02/93 | 4        | 5729           | 5786   |
| Cajun Queen No. 1           | 31-049 | 8/03/93 | 5        | 0              | 372    |
| Gold King                   | 31-067 | 8/02/93 | 4        | 5786           | 5839   |
| Bell of the Hills           | 31-072 | 7/22/93 | No video |                |        |
| Dillon Millsite             | 31-073 | 7/22/93 | 4        | 3748           | 3823   |
| Keystone                    | 31-074 | 8/02/93 | 1        | 5058           | 5088   |
| Little Anaconda             | 31-077 | 7/23/93 | 4        | 4048           | 4165   |
| Hopkins                     | 31-078 | 7/23/93 | No video |                |        |
| Nancy Lee Millsite          | 31-082 | 8/02/93 | 1        | 5160           | 5204   |
| Nancy Lee Millsite - Slowey | 31-090 | 9/07/93 | 6        | 3407           | 3550   |
| Ward Lode                   | 32-005 | 9/08/93 | 6        | 3610           | 3790   |
| Lost Cabin                  | 32-011 | 7/02/93 | No video |                |        |
| Linton                      | 32-017 | 7/01/93 | 4        | 966            | 1415   |
| Morse & Kennedy             | 32-033 | 7/01/93 | 1        | 3357           | 3448   |
| Jugget                      | 32-042 | 7/02/93 | No video |                |        |
| Upper Triantler             | 32-048 | 9/08/93 | 6        | 3530           | 3610   |
| Mill Creek Mine             | 32-049 | 9/08/93 | 6        | 3790           | 3873   |
| Hautilla                    | 32-057 | 7/02/93 | No video |                |        |
| McLaren Tailings            | 34-004 | 8/10/93 | 5        | 1871           | 2329   |
| Lower Glengarry             | 34-006 | 8/09/93 | 5        | 1443           | 1747   |
| Gold Dust                   | 34-007 | 8/09/93 | No video |                |        |
| Little Daisy                | 34-009 | 8/09/93 | 1        | 5408           | 5467   |
| McLaren Mine                | 34-010 | 8/09/93 | 1        | 5467           | 5533   |
| Allison                     | 34-018 | 8/12/93 | 5        | 2820           | 3015   |
| Black Warrior               | 34-079 | 8/09/93 | 1        | 5533           | 5558   |
| Upper Alice E.              | 34-085 | 8/10/93 | 1        | 5604           | 5672   |
| Fisher Creek No. 1          | 34-090 | 8/10/93 | 1        | 5558           | 5604   |
| Homestake No. 2             | 34-093 | 8/09/93 | 5        | 1747           | 1871   |
| Charter Oak                 | 39-003 | 6/11/93 | 1        | 1565           | 1810   |
| Charter Oak                 | 39-003 | 6/11/93 | 2        | 2490           | 2615   |
| Emery                       | 39-004 | 7/16/93 | 1        | 3836           | 4114   |
| Lilly Orphan Boy            | 39-006 | 6/28/93 | 2        | 5697           | 5800   |
| Monarch                     | 39-008 | 8/18/93 | 5        | 4402           | 4533   |
| Ontario Millsite            | 39-010 | 6/10/93 | 1        | 1506           | 1565   |
| Golden Anchor               | 39-012 | 7/14/93 | 4        | 2600           | 2700   |
| Hard Luck                   | 39-014 | 7/14/93 | 1        | 3506           | 3595   |
| Kimball                     | 39-018 | 8/18/93 | 5        | 4533           | 4637   |
| Sure Thing                  | 39-020 | 6/28/93 | 2        | 5540           | 5697   |
| Julia                       | 39-022 | 6/28/93 | 1        | 3060           | 3120   |
| Telegraph Mine              | 39-023 | 6/10/93 | 2        | 2350           | 2490   |

| SITE NAME            | PA No. | INVESTIGATION |          | #1LOG | START | FINISH |
|----------------------|--------|---------------|----------|-------|-------|--------|
|                      |        | DATE          | TAPE No. |       |       |        |
| Third Term           | 39-024 | 7/14/93       | 1        | 3595  | 3609  |        |
| Anna R./Hattie M     | 39-044 | 6/28/93       | 1        | 2932  | 3060  |        |
| NE NW S32            | 39-052 | 7/15/93       | 4        | 2850  | 3000  |        |
| Mountain View        | 39-062 | 7/14/93       | 4        | 2438  | 2600  |        |
| Viking               | 39-077 | 8/18/93       | 5        | 4637  | 4767  |        |
| Curlew               | 41-003 | 9/09/93       | 6        | 4075  | 4227  |        |
| Montana Prince       | 41-004 | 6/22/93       | No video |       |       |        |
| Blue Bird            | 41-009 | 9/08/93       | 6        | 3873  | 4075  |        |
| Lucky Joe            | 41-027 | 6/22/93       | 2        | 4453  | 4530  |        |
| Jack Waite           | 45-002 | 9/07/93       | 6        | 3305  | 3407  |        |
| Broken Hill          | 45-005 | 8/03/93       | 5        | 372   | 620   |        |
| Holliday             | 45-009 | 8/03/93       | 1        | 5204  | 5258  |        |
| Montro Gold          | 45-010 | 8/06/93       | 5        | 1150  | 1443  |        |
| Dee Creek            | 45-041 | 8/06/93       | 1        | 5394  | 5408  |        |
| Lower Letterman      | 45-047 | 8/06/93       | 5        | 827   | 1150  |        |
| Old Glory            | 47-027 | 8/24/93       | 5        | 5260  | 5326  |        |
| Highland Mine        | 47-028 | 9/17/93       | 6        | 5595  | 5686  |        |
| Clipper              | 47-029 | 8/24/93       | 5        | 5326  | 5520  |        |
| Mary Emmee/Clinton   | 47-035 | 8/20/93       | 3        | 1355  | 1522  |        |
| Rising Sun           | 47-037 | 9/14/93       | 6        | 5080  | 5188  |        |
| Maiden Rock          | 47-051 | 8/24/93       | No video |       |       |        |
| Middle Fork Millsite | 47-081 | 8/27/93       | 6        | 487   | 1002  |        |
| Mouat Mine           | 48-001 | 8/24/93       | 3        | 1522  | 1631  |        |
| Benbow               | 48-005 | 8/11/93       | 1        | 5672  | 5728  |        |
| Poorman/Emma         | 49-001 | 8/11/93       | 5        | 2664  | 2820  |        |
| Yager/Daisy          | 49-002 | 8/11/93       | 5        | 2329  | 2664  |        |
| NE SE S22            | 49-003 | 8/11/93       | No video |       |       |        |

# VIDEO TAPE NO. 1

| SITE NAME              | PA No. | INVESTIGATION<br>DATE | COUNTER<br>START | COUNTER<br>FINISH |
|------------------------|--------|-----------------------|------------------|-------------------|
| Carpenter Ck. Tailings | 07-103 | 5/24/93               | 0                | 110               |
| Silver Dyke Millsite   | 07-137 | 5/25/93               | 110              | 292               |
| Silver Dyke Tailings   | 07-137 | 5/26/93               | 292              | 523               |
| Sherman No. 2          | 07-140 | 5/26/93               | 523              | 614               |
| Big Seven              | 07-156 | 5/27/93               | 614              | 692               |
| Tiger                  | 23-059 | 6/3/93                | 692              | 904               |
| Moulton                | 23-058 | 6/3/93                | 904              | 983               |
| Belt Patent            | 23-035 | 6/4/93                | 983              | 1031              |
| Lucky Strike           | 23-042 | 6/4/93                | 1031             | 1092              |
| Big Ox Mine            | 25-116 | 6/9/93                | 1092             | 1317              |
| Big Ox Millsite        | 25-115 | 6/9/93                | 1317             | 1422              |
| Empire Mill            | 25-175 | 6/9/93                | 1422             | 1506              |
| Ontario Millsite       | 39-010 | 6/10/93               | 1506             | 1565              |
| Charter Oak            | 39-003 | 6/11/93               | 1565             | 1810              |
| Uncle Sam              | 29-383 | 6/16/93               | 1810             | 1923              |
| Smuggler               | 29-010 | 6/16/93               | 1923             | 1927              |
| Latest Out             | 29-354 | 6/17/93               | 1927             | 2140              |
| NE SE S26              | 29-476 | 6/17/93               | 2140             | 2152              |
| Emma                   | 29-061 | 6/18/93               | 2152             | 2290              |
| Banner                 | 20-175 | 6/21/93               | 2290             | 2349              |
| Old Dominion           | 20-180 | 6/21/93               | 2349             | 2390              |
| Granite Mtn.           | 20-110 | 6/22/93               | 2390             | 2420              |
| Bi-Metallic/Old Red    | 20-002 | 6/22/93               | 2420             | 2433              |
| Ermont Mill & Mines    | 01-005 | 6/14/93               | 2433             | 2831              |
| Indian Queen           | 01-034 | 6/15/93               | 2831             | 2932              |
| Anna R./Hattie M       | 39-044 | 6/28/93               | 2932             | 3060              |
| Julia                  | 39-022 | 6/28/93               | 3060             | 3120              |
| Wasa                   | 20-023 | 6/29/93               | 3120             | 3143              |
| Alps                   | 20-065 | 6/30/93               | 3244             | 3265              |
| Jackson Park           | 20-027 | 6/29/93               | 3265             | 3357              |
| Morse & Kennedy        | 32-033 | 7/01/93               | 3357             | 3448              |
| Beatrice               | 25-103 | 7/13/93               | 3448             | 3506              |
| Hard Luck              | 39-014 | 7/14/93               | 3506             | 3595              |
| Third Term             | 39-024 | 7/14/93               | 3595             | 3609              |
| Tenmile                | 25-005 | 7/15/93               | 3609             | 3797              |
| Lower Tenmile/Engstrom | 25-030 | 7/15/93               | 3797             | 3836              |
| Emery                  | 39-004 | 7/16/93               | 3836             | 4114              |
| Mammoth                | 29-008 | 7/19/93               | 4114             | 4211              |
| Mammoth Tailings       | 29-082 | 7/19/93               | 4211             | 4255              |
| Apex                   | 29-105 | 7/20/93               | 4255             | 4291              |
| Kearsage               | 29-102 | 7/20/93               | 4291             | 4307              |
| Blue Bird              | 22-003 | 7/08/93               | 4307             | 4357              |
| Marguerite             | 22-301 | 7/09/93               | 4357             | 4411              |
| Minah Mine             | 22-104 | 7/09/93               | 4411             | 4424              |
| Basin Millsite         | 22-036 | 7/09/93               | 4424             | 4488              |
| Perry's Park           | 22-039 | 7/09/93               | 4488             | 4525              |
| Corbin Flats           | 22-004 | 7/12/93               | 4525             | 4570              |
| Beatrice               | 25-103 | 7/13/93               | 4570             | 4698              |
| Miller Mtn.            | 04-138 | 7/26/93               | 4698             | 4725              |



# VIDEO TAPE NO. 1 - Continued

| SITE NAME             | PA No. | INVESTIGATION<br>DATE | COUNTER<br>START | COUNTER<br>FINISH |
|-----------------------|--------|-----------------------|------------------|-------------------|
| Vosburg               | 04-014 | 7/27/93               | 4725             | 4771              |
| East Pacific          | 04-008 | 7/27/93               | 4771             | 4830              |
| Diamond Hill          | 04-020 | 7/28/93               | 4830             | 4899              |
| Belle Of the Castle   | 30-007 | 7/29/93               | 4899             | 4940              |
| Cumberland            | 30-004 | 7/29/93               | 4940             | 4993              |
| Silver Belt           | 07-111 | 7/30/93               | 4993             | 5035              |
| Fairplay              | 07-112 | 7/30/93               | 5035             | 5058              |
| Keystone              | 31-074 | 8/02/93               | 5058             | 5088              |
| Nancy Lee Mine        | 31-001 | 8/02/93               | 5088             | 5160              |
| Nancy Lee Millsite    | 31-082 | 8/02/93               | 5160             | 5204              |
| Holliday              | 45-009 | 8/03/93               | 5204             | 5258              |
| Snowshoe              | 27-005 | 8/04/93               | 5258             | 5304              |
| Cherry Creek Millsite | 27-006 | 8/04/93               | 5304             | 5321              |
| Flathead Mine         | 15-012 | 8/05/93               | 5321             | 5394              |
| Dee Creek             | 45-041 | 8/06/93               | 5394             | 5408              |
| Little Daisy          | 34-009 | 8/09/93               | 5408             | 5467              |
| McLaren Mine          | 34-010 | 8/09/93               | 5467             | 5533              |
| Black Warrior         | 34-079 | 8/09/93               | 5533             | 5558              |
| Fisher Creek No. 1    | 34-090 | 8/10/93               | 5558             | 5604              |
| Upper Alice E.        | 34-085 | 8/10/93               | 5604             | 5672              |
| Benbow                | 48-005 | 8/11/93               | 5672             | 5728              |
| Elk Creek Corundum    | 16-013 | 8/12/93               | 5728             | 5741              |
| Karst Asbestos        | 16-018 | 8/13/93               | 5741             | 5770              |

**VIDEO TAPE NO. 2**

| <b>SITE NAME</b>     | <b>PA No.</b> | <b>INVESTIGATION<br/>DATE</b> | <b>COUNTER<br/>START</b> | <b>COUNTER<br/>FINISH</b> |
|----------------------|---------------|-------------------------------|--------------------------|---------------------------|
| Nellie Grant         | 22-244        | 5/18 & 19/93                  | 0                        | 120                       |
| Neihart Tailings     | 07-134        | 6/2/93                        | 120                      | 700                       |
| Evening Star Mill    | 07-087        | 6/2/93                        | 700                      | 1075                      |
| Bon Ton              | 07-094        | 6/3/93                        | 1075                     | 1269                      |
| Harrison             | 23-056        | 6/3/93                        | 1269                     | 1575                      |
| Marcelline           | 23-022        | 6/4/93                        | 1575                     | 1720                      |
| Wright Lode          | 23-045        | 6/7/93                        | 1720                     | 1918                      |
| Dakotah              | 07-121        | 6/8/93                        | 1918                     | 2350                      |
| Telegraph Mine       | 39-023        | 6/10/93                       | 2350                     | 2490                      |
| Charter Oak          | 39-003        | 6/11/93                       | 2490                     | 2615                      |
| Thistle No. 1        | 29-073        | 6/15/93                       | 2615                     | 3386                      |
| Broad Gauge          | 29-293        | 6/16/93                       | 3386                     | 3555                      |
| Smuggler             | 29-010        | 6/16/93                       | 3555                     | 3835                      |
| SE SW S26 (Keynote)  | 29-474        | 6/16/93                       | 3835                     | 3925                      |
| Pedro                | 29-455        | 6/18/93                       | 3925                     | 4125                      |
| Trout                | 20-062        | 6/21/93                       | 4125                     | 4453                      |
| Lucky Joe            | 41-027        | 6/22/93                       | 4453                     | 4530                      |
| Bluebird             | 22-003        | 7/08/93                       | 4530                     | 4588                      |
| Scratch All          | 20-019        | 6/22/93                       | 4538                     | 4750                      |
| Douglas Creek        | 20-003        | 6/23/93                       | 4750                     | 5075                      |
| Brooklin             | 20-025        | 6/24/93                       | 5075                     | 5338                      |
| Silver Lake Millsite | 12-070        | 6/25/93                       | 5338                     | 5540                      |
| Sure Thing           | 39-020        | 6/28/93                       | 5540                     | 5697                      |
| Lilly Orphan Boy     | 39-006        | 6/28/93                       | 5697                     | 5800                      |



# VIDEO TAPE NO. 3

| SITE NAME                    | PA No. | INVESTIGATION<br>DATE | COUNTER<br>START | COUNTER<br>FINISH |
|------------------------------|--------|-----------------------|------------------|-------------------|
| Tacoma                       | 22-284 | 8/16/93               | 0                | 206               |
| Queen (Tourmaline)           | 22-111 | 8/16/93               | 206              | 309               |
| Elkhorn Queen                | 22-027 | 8/16/93               | 309              | 472               |
| Middle Fk. Warm Springs      | 22-046 | 8/17/93               | 472              | 680               |
| Alhambra Hot Springs         | 22-049 | 8/17/93               | 680              | 800               |
| Bald Butte Millsite          | 25-179 | 8/18/93               | 800              | 930               |
| Wildcat                      | 25-317 | 8/18/93               | 930              | 1021              |
| Belmont                      | 25-167 | 8/19/93               | 1021             | 1134              |
| Bald Mtn.                    | 25-061 | 8/19/93               | 1134             | 1263              |
| Sourdough                    | 22-336 | 8/20/93               | 1263             | 1355              |
| Mary Emmee/Clinton           | 47-035 | 8/20/93               | 1355             | 1522              |
| Mouat Mine                   | 48-001 | 8/24/93               | 1522             | 1631              |
| Goldschmidt-Steiner          | 29-078 | 8/25/93               | 1631             | 1750              |
| Red Pine                     | 29-079 | 8/25/93               | 1750             | 1825              |
| Pacific                      | 29-118 | 8/26/93               | 1825             | 1965              |
| Easton                       | 29-121 | 8/26/93               | 1965             | 2127              |
| JTC                          | 29-106 | 8/27/93               | 2127             | 2202              |
| Buckeye                      | 29-451 | 8/27/93               | 2202             | 2406              |
| NE NW S13                    | 25-197 | 8/30/93               | 2406             | 2616              |
| SE SW S10                    | 25-212 | 8/30/93               | 2616             | 2661              |
| Pangewasset                  | 25-226 | 8/31/93               | 2661             | 2725              |
| Astor                        | 25-227 | 8/31/93               | 2725             | 2830              |
| Piegan/Gloster Mill          | 25-172 | 9/01/93               | 2830             | 2960              |
| Seven-Up Pete/Rover          | 25-020 | 9/07/93               | 2960             | 3033              |
| Blackfoot Tailings           | 25-322 | 9/07/93               | 3033             | 3195              |
| Nonpareil                    | 20-012 | 9/08/93               | 3195             | 3394              |
| Maxville Tails (Londonderry) | 20-209 | 9/09/93               | 3394             | 3500              |
| Ant                          | 20-194 | 9/09/93               | 3500             | 3605              |
| Lori No. 13                  | 20-191 | 9/10/93               | 3605             | 3642              |
| Cable                        | 12-002 | 9/10/93               | 3642             | 3665              |
| Norwegian                    | 29-006 | 9/13/93               | 3665             | 3779              |
| Boaz                         | 29-013 | 9/13/93               | 3779             | 3874              |
| Strawberry                   | 29-038 | 9/14/93               | 3874             | 4078              |
| Boss Tweed                   | 29-034 | 9/14/93               | 4078             | 4207              |
| Broadway/Victoria            | 29-179 | 9/17/93               | 4207             | 4262              |
| Atlantic & Pacific           | 29-033 | 9/15/93               | 4262             | 4385              |
| SE SE S25                    | 29-394 | 9/20/93               | 4385             | 4418              |





# VIDEO TAPE NO. 4

| SITE NAME              | PA No. | INVESTIGATION<br>DATE | COUNTER<br>START | COUNTER<br>FINISH |
|------------------------|--------|-----------------------|------------------|-------------------|
| Forest Rose            | 20-004 | 6/29/93               | 5                | 606               |
| Silver King            | 20-186 | 6/30/93               | 606              | 966               |
| Linton                 | 32-017 | 7/01/93               | 966              | 1415              |
| Bertha                 | 22-002 | 7/12/93               | 1425             | 2045              |
| Valley Forge/Susie     | 25-008 | 7/13/93               | 2045             | 2205              |
| Red Water              | 25-007 | 7/13/93               | 2205             | 2430              |
| Mountain View          | 39-062 | 7/14/93               | 2438             | 2600              |
| Golden Anchor          | 39-012 | 7/14/93               | 2600             | 2700              |
| Victory/ Evening Star  | 25-010 | 7/15/93               | 2700             | 2850              |
| NE NW S32              | 39-052 | 7/15/93               | 2850             | 3000              |
| Armstrong              | 25-102 | 7/15/93               | 3000             | 3298              |
| Champion               | 12-003 | 7/16/93               | 3298             | 3573              |
| Combination            | 20-009 | 7/21/93               | 3573             | 3748              |
| Dillon Millsite        | 31-073 | 7/22/93               | 3748             | 3823              |
| Iron Mountain Millsite | 31-010 | 7/22/93               | 3823             | 4048              |
| Little Anaconda        | 31-077 | 7/23/93               | 4048             | 4165              |
| Park (Marietta)        | 04-012 | 7/27/93               | 4165             | 4414              |
| St. Louis              | 04-013 | 7/27/93               | 4414             | 4559              |
| Bigler                 | 30-067 | 7/28/93               | 4559             | 4773              |
| Porcupine              | 30-069 | 7/28/93               | 4773             | 4828              |
| SE NW S24              | 30-017 | 7/28/93               | 4828             | 4936              |
| Lane                   | 30-019 | 7/28/93               | 4936             | 5010              |
| SE NE S10              | 30-078 | 7/28/93               | 5010             | 5148              |
| Vilipa                 | 07-080 | 7/29/93               | 5148             | 5506              |
| Molton                 | 07-084 | 7/29/93               | 5506             | 5625              |
| Tarbox-Mineral King    | 31-003 | 8/02/93               | 5625             | 5729              |
| Salteste Consolidate   | 31-021 | 8/02/93               | 5729             | 5786              |
| Gold King              | 31-067 | 8/02/93               | 5786             | 5839              |



# VIDEO TAPE NO. 5

| SITE NAME          | PA No. | INVESTIGATION<br>DATE | COUNTER<br>START | COUNTER<br>FINISH |
|--------------------|--------|-----------------------|------------------|-------------------|
| Cajun Queen No. 1  | 31-049 | 8/03/93               | 0                | 372               |
| Broken Hill        | 45-005 | 8/03/93               | 372              | 620               |
| Mitchell Creek     | 27-055 | 8/04/93               | 620              | 827               |
| Lower Letterman    | 45-047 | 8/06/93               | 827              | 1150              |
| Montro Gold        | 45-010 | 8/06/93               | 1150             | 1443              |
| Lower Glengarry    | 34-006 | 8/09/93               | 1443             | 1747              |
| Homestake No. 2    | 34-093 | 8/09/93               | 1747             | 1871              |
| McLaren Tailings   | 34-004 | 8/10/93               | 1871             | 2329              |
| Yager/Daisy        | 49-002 | 8/11/93               | 2329             | 2664              |
| Poorman/Emma       | 49-001 | 8/11/93               | 2664             | 2820              |
| Allison            | 34-018 | 8/12/93               | 2820             | 3015              |
| Thumper Mica       | 16-015 | 8/12/93               | 3015             | 3123              |
| Clara              | 01-262 | 8/13/93               | 3123             | 3232              |
| Washington         | 22-007 | 8/16/93               | 3232             | 3530              |
| Argentine          | 22-102 | 8/16/93               | 3530             | 3685              |
| Alta               | 22-001 | 8/17/93               | 3685             | 3876              |
| Gregory            | 22-005 | 8/17/93               | 3876             | 4215              |
| Wickes Tailings    | 22-358 | 8/17/93               | 4215             | 4402              |
| Monarch            | 39-008 | 8/18/93               | 4402             | 4533              |
| Kimball            | 39-018 | 8/18/93               | 4533             | 4637              |
| Viking             | 39-077 | 8/18/93               | 4637             | 4767              |
| SE SE S13          | 25-294 | 8/19/93               | 4767             | 4852              |
| Red Mtn. No. 13    | 25-019 | 8/19/93               | 4852             | 4984              |
| Davis Gulch        | 25-040 | 8/19/93               | 4984             | 5045              |
| Red Mtn. (North)   | 25-019 | 8/20/93               | 5045             | 5145              |
| Upper Valley Forge | 25-280 | 8/20/93               | 5145             | 5260              |
| Old Glory          | 47-027 | 8/24/93               | 5260             | 5326              |
| Clipper            | 47-029 | 8/24/93               | 5326             | 5520              |
| Last Chance No. 1  | 01-216 | 8/25/93               | 5520             | 5615              |
| Last Chance No. 2  | 01-220 | 8/25/93               | 5615             | 5664              |
| South Frying Pan   | 01-211 | 8/25/93               | 5664             | 5735              |





**VIDEO TAPE NO. 6**

| <b>SITE NAME</b>            | <b>PA No.</b> | <b>INVESTIGATION<br/>DATE</b> | <b>COUNTER<br/>START</b> | <b>COUNTER<br/>FINISH</b> |
|-----------------------------|---------------|-------------------------------|--------------------------|---------------------------|
| Silver King                 | 01-094        | 8/26/93                       | 0                        | 148                       |
| Trapper                     | 01-144        | 8/26/93                       | 148                      | 487                       |
| Middle Fork Millsite        | 47-081        | 8/27/93                       | 487                      | 1002                      |
| Spring Hill Tailings        | 25-067        | 8/30/93                       | 1002                     | 1499                      |
| Lady Luck                   | 25-073        | 8/30/93                       | 1499                     | 1595                      |
| Mother Lode                 | 25-363        | 8/31/93                       | 1595                     | 1663                      |
| Franklin                    | 25-339        | 8/31/93                       | 1663                     | 2068                      |
| Swawnsea Tailings           | 25-208        | 9/01/93                       | 2068                     | 2165                      |
| Goldsil Millsite            | 25-365        | 9/02/93                       | 2165                     | 2770                      |
| Ohio                        | 04-009        | 9/03/93                       | 2770                     | 2935                      |
| Keatings Tailings           | 04-121        | 9/03/93                       | 2935                     | 3188                      |
| Eleanor East                | 29-285        | 9/04/93                       | 3188                     | 3305                      |
| Jack Waite                  | 45-002        | 9/07/93                       | 3305                     | 3407                      |
| Nancy Lee Millsite - Slowey | 31-090        | 9/07/93                       | 3407                     | 3550                      |
| Upper Triantler             | 32-048        | 9/08/93                       | 3530                     | 3610                      |
| Ward Lode                   | 32-005        | 9/08/93                       | 3610                     | 3790                      |
| Mill Creek Mine             | 32-049        | 9/08/93                       | 3790                     | 3873                      |
| Blue Bird                   | 41-009        | 9/08/93                       | 3873                     | 4075                      |
| Curlew                      | 41-003        | 9/09/93                       | 4075                     | 4227                      |
| Martin                      | 01-270        | 9/09/93                       | 4233                     | 4308                      |
| Vortex                      | 23-027        | 9/10/93                       | 4308                     | 4392                      |
| NE NE S31                   | 23-079        | 9/10/93                       | 4392                     | 4467                      |
| Tail Holt                   | 14-010        | 9/11/93                       | 4467                     | 4592                      |
| Cumberland                  | 14-017        | 9/11/93                       | 4592                     | 4730                      |
| Tungsten Millsite           | 01-170        | 9/13/93                       | 4730                     | 4895                      |
| Lower Cleve                 | 01-143        | 9/14/93                       | 4895                     | 5080                      |
| Rising Sun                  | 47-037        | 9/14/93                       | 5080                     | 5188                      |
| Old Elkhorn                 | 01-169        | 9/15/93                       | 5188                     | 5275                      |
| Garrett Hill                | 01-092        | 9/15/93                       | 5275                     | 5391                      |
| Gold Leaf/Priscilla         | 01-031        | 9/16/93                       | 5391                     | 5595                      |
| Highland Mine               | 47-028        | 9/17/93                       | 5595                     | 5686                      |
| Watseca Mill                | 29-075        | 9/20/93                       | 5686                     | 5745                      |

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**NO VIDEO TAKEN****INVESTIGATION**

| <b>SITE NAME</b>      | <b>PA No.</b> | <b>DATE</b> |
|-----------------------|---------------|-------------|
| Apex Millsite         | 01-006        | 9/16/93     |
| Argo                  | 04-015        | 7/26/93     |
| Hummingbird           | 04-144        | 7/26/93     |
| Compromise            | 07-100        | 6/1/93      |
| Rochester             | 07-110        | 6/2/93      |
| Atlantus              | 07-113        | 6/2/93      |
| Stallabrass           | 07-120        | 7/30/93     |
| Maud S.               | 07-129        | 6/8/93      |
| Silver Dike Adit      | 07-135        | 6/1/93      |
| Sherman No. 2         | 07-142        | 5/26/93     |
| Baker                 | 07-180        | 7/29/93     |
| Gold Coin             | 12-004        | 6/25/93     |
| Algonquin             | 20-005        | 6/23/93     |
| Rumsey Mine/Millsite  | 20-018        | 6/24/93     |
| True Fissure          | 20-111        | 6/23/93     |
| Bullion               | 22-008        | 7/06/93     |
| Comet Tailings        | 22-009        | 7/08/93     |
| Grey Eagle            | 22-029        | 7/09/93     |
| Mantle (East)         | 22-032        | 7/07/93     |
| Solar Silver          | 22-054        | 8/17/93     |
| Buckeye               | 22-072        | 7/06/93     |
| Crystal               | 22-073        | 7/07/93     |
| Enterprise            | 22-074        | 7/06/93     |
| Eva May               | 22-075        | 7/07/93     |
| Morning Glory         | 22-077        | 7/07/93     |
| General Grant         | 22-245        | 5/19/93     |
| Jack Creek Tailings   | 22-296        | 7/06/93     |
| Galena Creek Sampling | 23-001        | 6/7/93      |
| Edwards Lode          | 23-046        | 6/7/93      |
| Argo Millsite         | 25-314        | 9/02/93     |
| Silver Cable          | 27-066        | 8/04/93     |
| B&H                   | 29-083        | 7/23/93     |
| General Shafter       | 29-103        | 7/21/93     |
| Dry Gulch (South)     | 29-282        | 7/20/93     |
| Missouri              | 29-373        | 7/22/93     |
| Grubstake             | 29-399        | 7/22/93     |
| Lakeshore             | 29-436        | 7/21/93     |
| Pete & Joe            | 29-449        | 7/23/93     |
| Ohio                  | 29-473        | 7/20/93     |
| Bell of the Hills     | 31-072        | 7/22/93     |
| Hopkins               | 31-078        | 7/23/93     |
| Lost Cabin            | 32-011        | 7/02/93     |
| Nugget                | 32-042        | 7/02/93     |
| Hautilla              | 32-057        | 7/02/93     |
| Gold Dust             | 34-007        | 8/09/93     |
| Montana Prince        | 41-004        | 6/22/93     |
| Maiden Rock           | 47-051        | 8/24/93     |
| NE SE S22             | 49-003        | 8/11/93     |



